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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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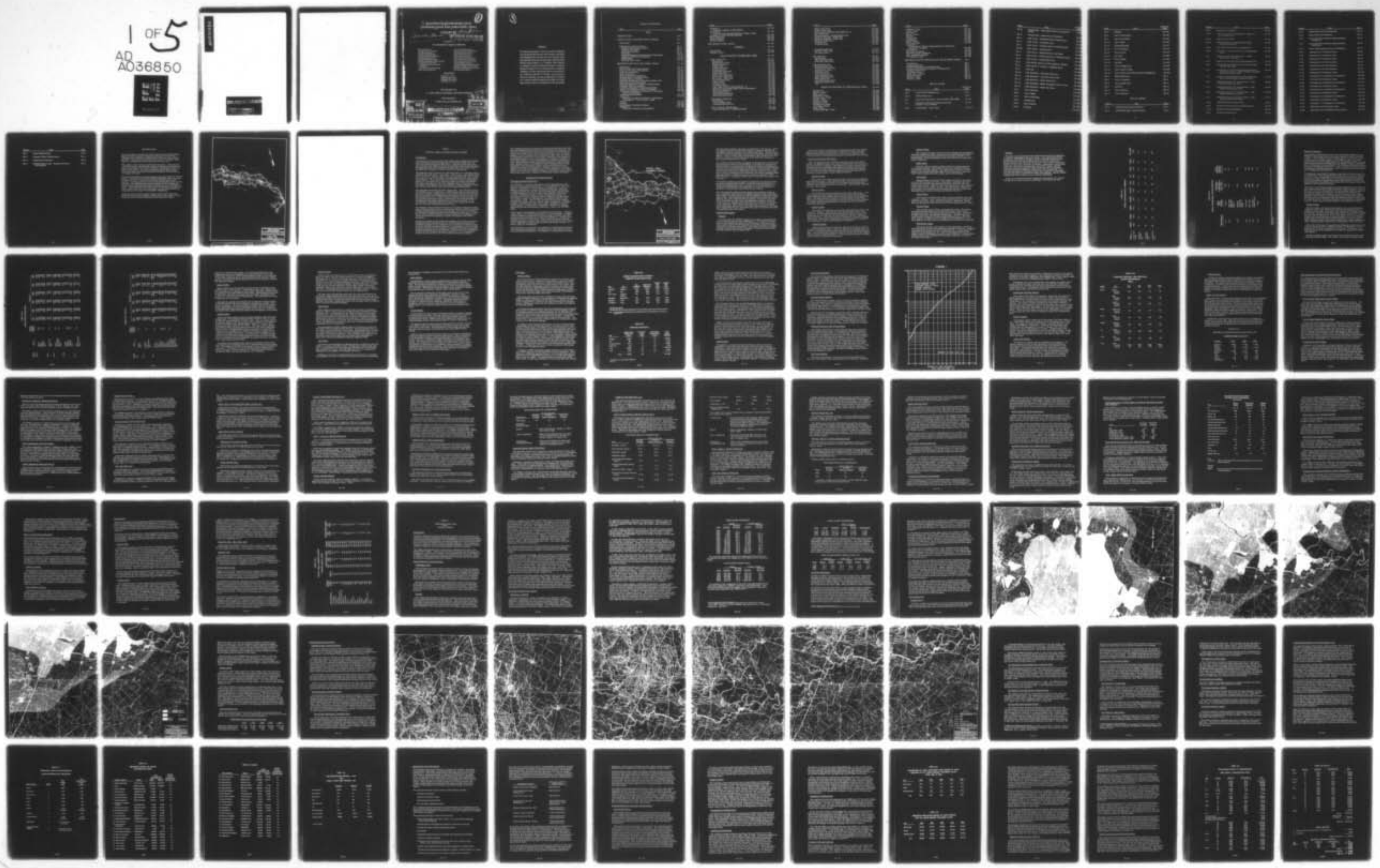

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(6) # WASTEWATER MANAGEMENT PLAN, COLORADO RIVER AND TRIBUTARIES, TEXAS.

VOLUME VII. Lower Basin Areawide Plan.

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Prepared by

THE GOVERNOR'S PLANNING COMMITTEE

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Texas Water Quality Board
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Lower Colorado River Authority
Colorado River Municipal Water District
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Upper Colorado River Authority
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Alamo Area Council of Governments
Central Texas Council of Governments
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PREFACE

The information presented in this volume consists of background and technical data that were used in the formulation of the Wastewater Management Plan, Colorado River and Tributaries, Texas, dated September 1973, which was approved by the Environmental Protection Agency Region VI on 4 December 1973. These data are intended for use by the affected communities in the basin as background material for future planning actions in wastewater management and other water quality fields. For those communities considering application for treatment works construction grants, this information can serve as a data base for the preparation of material required in Sections 201 and 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

TABLE OF CONTENTS

Title	Page
TEXT	
INTRODUCTION	LB-1
CAPITAL AREA PLANNING COUNCIL REGION	CA-1
Introduction	CA-1
Planning Area Characteristcs	CA-2
Existing Institutional Structure	CA-2
Physical Description	CA-3
Population Analysis	CA-9
Hydrology	CA-15
Existing Industrial and Agricultural Operations	CA-22
Wasteload Allocation Discussion	CA-37
Segmentation	CA-38
Existing Waste Loads	CA-39
METROPOLITAN PLAN FOR AUSTIN, TEXAS	CA-41
Introduction	CA-41
Metropolitan Area Characteristics	CA-41
Social and Economic Description	CA-42
Land Use Projections	CA-45
Water Resources	CA-46
Existing Wastewater Systems	CA-48
Existing Water Treatment Plants	CA-50
Existing Sanitary Landfills	CA-51
Industrial Wastewaters in the Metropolitan Area	CA-52
Agricultural and Urban Runoff	CA-57
Proposed Wastewater Systems Considerations	CA-59
Proposed Collection System	CA-61
Proposed Wastewater Treatment Facilities	CA-68
Plans to Meet Highest Level of Treatment	CA-86
Treatment Alternatives, Evaluation, Conclusions and Recommendation	CA-128
Continuing Responsibility	CA-133
Appendix A	CA-137
Municipal Treatment Facilities - Operational Investigation - City of Austin, Texas	
Preface	CA-137
General	CA-137
Description of Existing Facilities	CA-138
Appendix B	CA-141
Evaluation Analysis of Alternatives	

Title	Page
Appendix C	CA-143
Economic Analysis of Alternatives	
Appendix D	CA-153
Land Disposal Alternatives City of Austin, Texas	
Evaluation of Land Disposal Methods	CA-153
Rapid Infiltration	CA-158
Spray Irrigation	CA-158
Overland Runoff	CA-163
NON-METRO PLANS, CAPCO	CA-167
GENERAL	CA-167
Introduction	CA-167
Design Criteria	CA-167
AREAS ADJACENT TO HIGHLAND LAKES	CA-169
Lake Travis Area	CA-171
Introduction	CA-171
Marshall Ford Area	CA-172
Windy Point Area	CA-173
Volente Area	CA-174
Hudson Bend Area	CA-175
Jonestown Area	CA-176
Trails End Road Area	CA-177
Buffalo Gap Area	CA-178
Hurst Creek Arm Area	CA-178
Bee Creek - East Area	CA-179
Bee Creek - West Area	CA-180
Therman Bend Area	CA-181
Point Venture	CA-182
Lakeway Area	CA-183
Cox Hollow Area	CA-187
Lago Vista (Travis County MUD No. 1)	CA-188
Whitecliff Corporation (Lake Travis Townhouses)	CA-190
Old Ferry Road Area	CA-190
Gloster Bend Area	CA-191
Pedernales County Club	CA-192
Spicewood Beach Area	CA-192
Lake Marble Falls Area	CA-194
Introduction	CA-194
City of Marble Falls	CA-195
Cottonwood Shores Area	CA-197
Lake Lyndon B. Johnson Area	CA-199
Lake LBJ MUD No. 1 (Horseshoe Bay)	CA-200

Title	Page
Sandy Creek Area	CA-202
Walnut Creek Area	CA-203
Sunrise Beach (Sunrise Beach MUD No. 1)	CA-204
Dry Creek Area	CA-206
Sherwood Shores - Granite Shoals Area	CA-207
Backbone Mountain - South Area	CA-208
Backbone Mountain - North Area	CA-209
Williams Creek Area	CA-209
Haywood Area	CA-210
Kingsland Area	CA-211
Kingsland Lake Area	CA-212
Hoovers Valley Area	CA-213
Murchison Area	CA-214
Inks Lake Area	CA-217
Introduction	CA-217
Inks Lake State Park	CA-218
North Inks Lake Area	CA-218
Lake Buchanan Area	CA-221
Buchanan Dam Area	CA-222
Wirth Haven Cove Area	CA-223
Jeckers Cove Area	CA-224
Negrohead Area	CA-225
Rock Point Area	CA-225
Lion Mountain Area	CA-226
Spider Mountain Area	CA-227
White Bluff Area	CA-228
Alexander Branch Area	CA-229
Maxwells Slough Area	CA-230
Tow	CA-230
AREAS NOT ADJACENT TO THE HIGHLAND LAKES	CA-233
Introduction	CA-233
Bastrop, Texas	CA-233
Elgin, Texas	CA-237
Smithville, Texas	CA-242
Johnson City, Texas	CA-246
Burnet, Texas	CA-249
Carmine, Texas	CA-253
Ellinger, Texas	CA-255
Fayetteville, Texas	CA-258
La Grange, Texas	CA-261
Buda, Texas	CA-264
Dripping Springs, Texas	CA-268

Title	Page
Giddings, Texas	CA-271
Llano, Texas	CA-275
Del Valle	CA-279
Manor, Texas	CA-280
Oak Hill	CA-284
Pflugerville	CA-285
Rollingwood	CA-287
Sunset Valley	CA-288
West Lake Hills	CA-289
Appendix A	
A Rationale for Phased Implementation of Wastewater Treatment Processes	CA-291
Introduction	CA-291
Secondary Treatment	CA-291
Best Practicable Treatment	CA-293
Best Treatment Feasible	CA-294
The Highland Lakes	CA-295
AREAWIDE PLAN FOR HOUSTON-GALVESTON AREA COUNCIL	HG-1
Introduction	HG-1
Planning Authority	HG-1
Physical Description of Planning Area	HG-1
Social and Economic Description of Planning Area	HG-2
Existing Waste Loads	HG-5
Columbus, Texas	HG-5
Eagle Lake, Texass	HG-9
Garwood, Texas	HG-13
Weimer, Texas	HG-16
Wharton, Texas	HG-19

LIST OF PLATES

Plate	Title	Following Page
LB-1	Lower Basin Planning Area	LB-1
CA-A	CAPCO Study Area	CA-2
A-1	Land-Use Projections - City of Austin (1980-2020)	CA-46
A-2	Existing and Proposed Sanitary Sewerage Systems - City of Austin	CA-48
HL-A	Vicinity Map - Lake Travis	CA-170

Plate	Title	Following Page
HL-B	Vicinity Map - Lake Marble Falls and Lyndon B. Johnson	CA-17
HL-C	Vicinity Map - Lakes Inks and Buchanan	CA-17
HL-1	Lake Travis - Mansfield Dam to Hudson Bend	CA-17
HL-2	Lake Travis - Jonestown Area	CA-17
HL-3	Lake Travis - Arkansas Bend to Therman Bend	CA-178
HL-3a	Lake Travis - Lakeway Area	CA-184
HL-4	Lake Travis - Baldwin Bend to Pace Bend	CA-188
HL-5	Lake Travis - Pedernales River to Muleshoe Bend	CA-192
HL-6	Lake Travis - Turkey Bend Area	CA-192
HL-7	Lake Marble Falls and Lake Lyndon B. Johnson	CA-196
HL-8	Lake Lyndon B. Johnson - Kingsland Area	CA-208
HL-9	Lake Inks	CA-214
HL-10	Lake Buchanan - Buchanan Dam Area	CA-222
HL-11	Lake Buchanan - Lakeshore Drive Area	CA-224
HL-12	Lake Buchanan - Rocky Point Area	CA-226
HL-13	Lake Buchanan - Spider Mountain to Silver Creek	CA-228
HL-14	Lake Buchanan - Upper Lake Area	CA-230
CA-1	City of Bastrop	CA-236
CA-2	City of Elgin	CA-240
CA-3	City of Smithville	CA-244
CA-4	Johnson City	CA-248
CA-5	City of Burnet	CA-252
CA-6	Carmine	CA-254

Plate	Title	Following Page
CA-7	Ellinger	CA-256
CA-8	City of Fayetteville	CA-260
CA-9	City of La Grange	CA-264
CA-10	City of Buda	CA-266
CA-11	Dripping Springs	CA-270
CA-12	City of Giddings	CA-274
CA-13	City of Llano	CA-278
CA-14	Del Valle	CA-280
CA-15	City of Manor	CA-282
CA-16	Oak Hill	CA-284
CA-17	City of Pflugerville	CA-286
CA-18	City of Sunset Valley	CA-288
CA-19	City of West Lake Hills and City of Rollingwood	CA-290
HG-A	HGAC Study Area	HG-2
HG-1	City of Columbus	HG-8
HG-2	City of Eagle Lake	HG-12
HG-3	Garwood	HG-14
HG-4	City of Weimar	HG-18
HG-5	City of Wharton	HG-22

LIST OF TABLES

Tables	Title	Page
CA-1	CAPCO Climatological Summary	CA-7
CA-2	CAPCO Hydrologic Characteristics	CA-8

Tables	Title	Page
CA-3	Population Projections	CA-10
CA-4	Lower Colorado River Authority - Dams on the Colorado River	CA-16
CA-5	Highland Lakes Data	CA-16
CA-6	Projected Municipal and Industrial Water Requirements (mgd)	CA-20
CA-7	Historical Surface Water Irrigation Use	CA-21
CA-8	Capital Area Planning Council - Existing Waste Loads	CA-40
A-1	Industrial Waste Characteristics - Austin Metropolitan Industries	CA-53
A-2	Industries Within the Austin Metropolitan Area	CA-54
A-3	Raw Wastewater Influent Data for Fiscal Years 1964 Through 1969	CA-56
A-4	Percentage of Total Developed Area Served by Each Existing City of Austin Sewage Treatment Plant From 1980 to 2020	CA-62
A-5	Projected Population Served by Each Existing City of Austin Sewage Treatment Plant	CA-62
A-6	Collection System "A" Improvements - 1980 Capital Construction Costs	CA-65
A-7	Collection System "B" Improvements - 1980 Capital Construction Costs	CA-69
A-8	Collection System "C" Improvements - 1980 Capital Construction Costs	CA-70
A-9	Collection System "D" Improvements - 1980 Capital Construction Costs	CA-71
A-10	1980 Relief Sewer Capital Costs	CA-72
A-11	Proposed Collection System Improvements	CA-73
A-12	Walnut Creek Cost Summary	CA-77
A-13	Govalle Cost Summary	CA-79

Tables	Title	Page
A-14	Williamson Creek Cost Summary	CA-80
A-15	Onion Creek Cost Summary	CA-81
A-16	Interceptor Sewer Systems Regionalization Alternative	CA-83
A-17	Interceptor Sewer Systems Regionalization Alternative	CA-84
A-18	Onion Creek Regional Plant Cost Summary	CA-85
A-19	Alternative B-1 Summary Costs	CA-88
A-20	Alternative B-2 Summary Costs	CA-91
A-21	Alternative B-3 Summary Costs	CA-93
A-22	Alternative B-4A Cost Summary	CA-95
A-23	Alternative B-4B Cost Summary	CA-97
A-24	Alternative B-4C Cost Summary	CA-98
A-25	Alternative B-5 Summary Costs	CA-101
A-26	Alternative B-5 Irrigation Cost Summary	CA-102
A-27	Alternative B-6 Summary Costs	CA-106
A-28	Alternative B-6 Irrigation Cost Summary	CA-107
A-29	Alternative B-7 Summary Costs	CA-111
A-30	Alternative B-7 Irrigation Cost Summary	CA-112
A-31	Alternative B-8 Summary Costs	CA-115
A-32	Alternative B-8 Irrigation Cost Summary	CA-117
A-33	Alternative B-9 Summary Costs	CA-120
A-34	Alternative B-9 Irrigation Cost Summary	CA-122
A-35	Alternative B-10 Summary Costs	CA-125
A-36	Alternative B-10 Irrigation Cost Summary	CA-127

Tables	Title	Page
HG-1	Water Requirements	HG-3
HG-2	Irrigation Water Requirements	HG-3
HG-3	Population Projections	HG-4
HG-4	Existing Waste Loads - Houston-Galveston Area Council	HG-6

INTRODUCTION

The Lower Basin is comprised of that portion of the Colorado River Basin which lies within two regional councils: The Capital Area Planning Council (CAPCO) and the Houston-Galveston Area Council (H-GAC). The study area includes all or part of 13 counties within these two jurisdictional entities as shown on Plate LB-1.

This volume of the report is divided into four parts. The first part covers the Capital Area Planning Council in general and presents an overall description of the social, economic, and physical characteristics of this region. Part two presents the Austin Metropolitan Plan and includes existing and proposed background data necessary to complete this task.

Part three presents the non-metropolitan area plans within the CAPCO region. The majority of the basic data pertaining to these areas was presented in Part I. This part of the study was divided into two sections. The first section covers the non-metropolitan areas located adjacent to the Highland Lakes and the second section includes the remaining non-metropolitan areas not adjacent to one of the Highland Lakes. This subdivision was made due to the different social and economic characteristics of these two areas, as well as their different requirements with respect to wastewater management.

The fourth part covers the small portion of the H-GAC which lies within the Colorado River Basin. Within that section, plans are presented for the five non-metropolitan areas within this region.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LOWER BASIN
PLANNING AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

PLATE: LB-1

PART I

CAPITAL AREA PLANNING COUNCIL REGION

Introduction.

This section of the report covers that reach of the Colorado River Basin within the Capital Area Planning Council (CAPCO) jurisdiction. The area is shown graphically in Plate CA-A. Included in this area is the City of Austin, the largest of the six metropolitan areas within the Basin, the Highland Lakes chain extending through Llano, Burnet and Travis Counties, and a number of cities, towns, and communities.

The Highland Lakes consist of six man-made lakes in a continuous chain along the Colorado River: Lake Austin, Lake Travis, Lake Marble Falls, Lake Lyndon B. Johnson, Inks Lake, and Lake Buchanan. Lake Austin, the lower-most lake in the chain, is located within the city limits of the City of Austin. Due to its location with respect to Austin, development adjacent to Lake Austin was considered under the Austin metropolitan area plan separately from the other Highland Lakes. Therefore, for this report, the Highland Lakes are assumed to begin at Mansfield Dam, which forms Lake Travis, and continue through Lake Buchanan.

The discussion is divided into three major parts. The first part covers the CAPCO area as a single unit. A general description of the physical, social and economic characteristics is presented. The second part consists of the Austin metropolitan area plan, and the third part covers the non-metropolitan area. The third part is divided into two sections: the first section covers those towns, communities, and cities adjacent to the Highland Lakes whose origin and/or existence is entirely, or for the most part, dependent upon the presence of the lakes; the second section covers the remaining towns and cities.

The purpose of this section of the report is to present alternative wastewater treatment plans based on existing and proposed conditions utilizing existing planning studies as much as possible. The collection systems as well as the treatment facilities are considered in this study. A rationale for phased implementation of proposed wastewater treatment processes is presented as Appendix A at the conclusion of the CAPCO discussion.

Alternative designs for the Austin metropolitan area include conceptual designs to meet the requirements of PL 92-500, as well as alternative conceptual designs to meet a highest level of treatment objective which would not constrain subsequent water use. In meeting the criteria for highest level of treatment, the alternative methods of treatment considered included biological, physical-chemical, land disposal, and combinations of these three methods of wastewater treatment. A cost comparison analysis is also presented for the alternative treatment methods.

The conceptual designs presented for the non-metropolitan areas adjacent to the Highland Lakes include recommendations for the highest practical level of treatment by 1975 due to the concern for preserving the quality of the water in the chain of man-made lakes. The conceptual designs for the remaining non-metropolitan areas include provisions for meeting the objectives of PL 92-500. Generally, this consists of proposing facilities to meet a high degree of secondary treatment by 1977, and provision of a practicable method of tertiary treatment by 1983. The method of tertiary treatment proposed for these communities consists of either conventional tertiary treatment units or land application of the secondary effluent, where soils exist which are suited to this method of treatment. It should be noted that a well designed and operated land disposal site for the application of secondary effluent can produce an effluent equivalent to the highest quality obtainable by any of the other methods of conventional tertiary treatment.

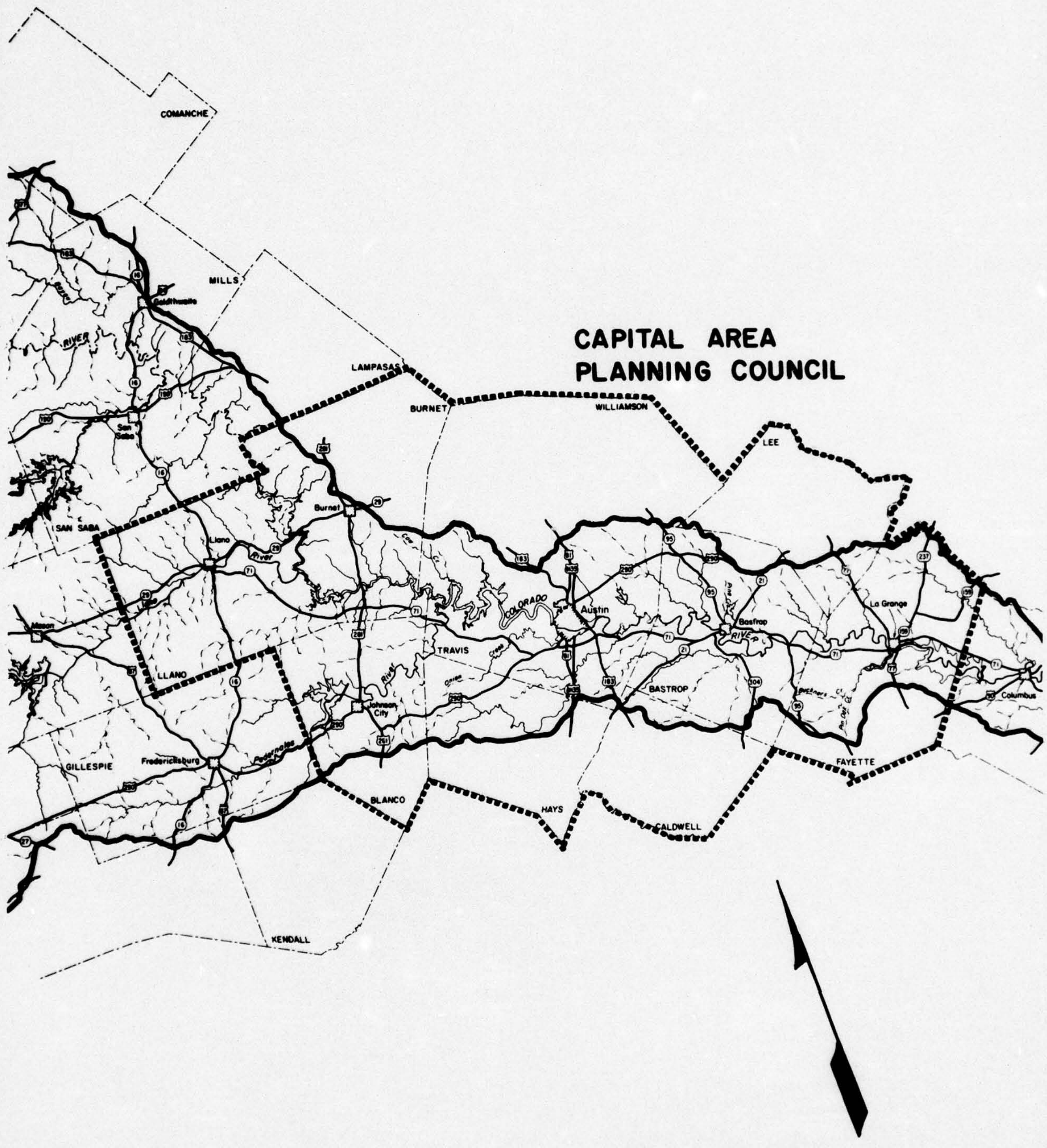
Planning Area Characteristics

Existing Institutional Structure.

The CAPCO is a voluntary association of local governments in the Central Texas region around Austin. It was organized in June 1970, under the legislation of Article 1011 M, Vernon's Annotated Civil Statutes, as amended, to study and discuss community challenges of mutual interest and concern, and to develop plans, policies, and recommendations for the ten-county region which it is authorized to serve. CAPCO has grown to serve a membership which now includes nine counties: Bastrop, Burnet, Caldwell, Fayette, Hays, Lee, Llano, Travis, and Williamson, with Blanco being the tenth non-member county. The 23 cities served within the nine member counties are Austin, Bastrop, Burnet, Elgin, Georgetown, Giddings, Granger, Granite Shoals, Kyle, La Grange, Lexington, Lockhart, Luling, Manor, Marble Falls, Pflugerville, Round Rock, Rollingwood, San Marcos, Schulenburg, Smithville, Taylor, and Westlake Hills.

Three types of membership are provided for in the Bylaws. Counties, cities, towns, and villages are eligible for full membership. Independent and common school districts, water, sewer, hospital, and other special purpose districts may be Associate Members. Affiliate memberships are open to other local, State, and Federal governmental units or agencies, to publicly and privately owned utilities, and to non-profit organizations specifically concerned with health, welfare, economic, and civic development.

The CAPCO General Assembly is composed of representatives elected by each member government. Meeting no fewer than three times per year, the General Assembly is responsible for establishing the overall



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WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CAPCO STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

PLATE: CA-A

policies and the specific objectives and purposes of the Council. State law requires that two-thirds of the Council's voting membership be composed of elected officials from counties and cities. Between meetings of the General Assembly, an Executive Committee governs Council affairs. Council officers and representatives duly appointed from the General Assembly membership make up the Executive Committee, which meets regularly each month.

As a council of governments, recognized by the Governor of Texas and by the Executive Office of the President, the CAPCO is charged with being involved in a comprehensive regional development planning process and with conducting review and comment on local government applications for projects to be financed with State or Federal funds. The Council itself operates on funds drawn from the Council's membership dues, which are matched in turn with State and Federal planning grants. Although CAPCO is defined by law as a political subdivision of the State of Texas, it possesses neither power of taxation nor powers of enforcement.

The Council employs a small staff of professional and support personnel whose responsibilities include formulation and maintenance of studies and planning documents, provision of technical assistance to the Council membership, and preparation of recommendations for adoption of regional plans and policies by the Council.

The Colorado River Basin has four State-created entities known as river authorities which have been assigned implementing responsibilities related to certain phases of water development within their designated areas. These agencies are the Colorado River Municipal Water District, the Upper Colorado River Authority, the Central Colorado River Authority, and the Lower Colorado River Authority which includes six of the counties within the CAPCO jurisdiction. In addition, a large number of other State-created agencies, such as municipal water authorities, water control and improvement districts, and fresh water supply districts are concerned with water development activities in designated parts of the Basin.

Physical Description.

Geology.

The area within the CAPCO consists of two distinct geological entities; one igneous and the other sedimentary. The upper or western portion of the region falls within the Llano Basin, also known as the Llano Uplift and Central Mineral Region consisting largely of igneous formations of Precambrian granite. The lower portion of the region consists of sedimentary strata consisting of limestone layered with clay and areas of clay and sandy soils.

An inventory of all of the general soil types found within the CAPCO region is too lengthly to present here. Specific soil types with their characteristics are discussed in the text for each community, town, or city covered in the metropolitan and non-metropolitan area sections.

Social and Economic Description.

There are generally three different economies within the CAPCO region: the Highland Lakes area west of Austin which relies on recreation and tourism in addition to agriculture; the Austin area which is a metropolitan area containing many different economic features; and the lower portion of the study area which relies primarily on agriculture. A brief description follows indicating the overall physical and economic characteristics of each county in CAPCO.

Bastrop County.

The gently rolling hills and fertile soils of the County support an agricultural economy. Light manufacturing, and tourists and weekend visitors to recreational facilities of Lake Bastrop and Bastrop and Buescher State Parks also add to the economy. The principal minerals are clay, oil, and gas.

Blanco County.

The County lies in the southwest corner of the study area. It is a hilly ranch county drained by the Pedernales River and the Blanco River (Guadalupe River Basin) and is covered mostly by thin limestone soils. The chief sources of income are sheep, goats, and turkeys. The tourist business has flourished in recent years due to the presence of Lyndon Johnson's boyhood home in Johnson City and the Johnson Ranch near Stonewall.

Burnet County.

The County is bounded on the west by Lakes Buchanan, Inks, and Lyndon B. Johnson. Lake Marble Falls and the upper end of Lake Travis are located along the southern portion of Burnet County. The topography is very hilly and rich with deposits of granite, graphite, sand, and gravel. The chief sources of income are livestock, mining, and tourists. Retirement communities developing along the lakes provide the greatest source of new income to the County.

Caldwell County.

Only a portion of the northeastern edge of the County is located in the Colorado River Basin. However, this portion contains rich, productive, clay blackland soils which contribute to the agricultural economy. The County's most important natural resource is the oil found in several fields located generally in a strip traveling through the middle of the County in a north-south direction.

Fayette County.

The County is strongly characterized by farming and agribusiness with some moderately heavy commercial and manufacturing activities located primarily in the principal cities (La Grange, Flatonia, and Schulenburg). Minerals produced in the County include oil, gas, sand, gravel, and stone.

Hays County.

Only the northern portion of Hays County is located within the Colorado River Basin. The County is known for springfed streams, scenic hills, and rustic beauty. The major source of income in that portion of the County within the study area is agriculture, ninety percent of which consists of cattle, sheep, goats, and dairying.

Lee County.

Approximately one-fourth of the County is forested, but the timber is of little commercial value. Agriculture constitutes the major income with a general trend towards livestock, since the soils are not particularly rich. Mineral resources consist of fire clay, Fuller's earth, sand, gravel, lignite, and oil. Only oil and gas, produced as a by-product, are commercially developed and only on a small scale. Manufacturing activities are small and limited in number.

Llano County.

The County is bounded on the east by Lakes Buchanan, Inks, and Lyndon B. Johnson. It is a ranch county with much of its income coming from beef cattle, hogs, and other livestock. Additional income has been obtained in recent years from lake development in the County.

Travis County.

The economy of the County is dominated by Austin, the largest metropolitan area within the Colorado River Basin, and is based primarily upon State and Federal governmental activities, institutions of higher education, and military installations. Livestock and livestock products comprise the bulk of agricultural income, while lime, sand, gravel, and stone are the principal minerals produced. The areas adjacent to Lake Travis are influenced by recreation and tourism.

Williamson County.

The major income of the County is from agriculture, which has been shifting away from crop production and toward livestock. Business is dominated by retail and service establishments, a large number of which are located along I.H. 35. Only a very small portion of the southern edge of Williamson County is located within the Colorado River Basin, and only one community in the County, Jollyville, is located partially in the Basin.

Climate.

The study area experiences both continental and maritime influences on weather, depending on the time of year. The annual precipitation across the Colorado River Basin is found to diminish rapidly as one moves westward, and varies within the area from 36.52 inches in Fayette County on the east to 27.59 inches in Llano County on the west. Table CA-1 provides a summary of rainfall, temperature, and growing season for each of the counties within the CAPCO region. Monthly reservoir evaporation data have been prepared by the Texas Water Development Board (TWDB) for Texas from 1940 through 1965. The data were presented by dividing the State into a system of quadrangles along the one-degree parallels of latitude and longitude. The ten CAPCO counties fall all or in part of seven of these quadrangles.

Table CA-2 presents the State-designated quadrangles, the counties that fall all or in part within the quadrangle, and evaporation data.

TABLE CA-1

CAPCO CLIMATOLOGICAL SUMMARY

COUNTY	BASTROP	BLANCO	BURNET	CALDWELL	FAYETTE	HAYS	LEE	LLANO	TRAVIS	WILLIAMSON
Annual rainfall (inches)	36.22	34.26	30.40	32.63	36.52	33.88	35.88	27.59	32.58	33.99
Average min. - temperature (°F)	40	36	37	41	42	40	40	34	41	39
Average max. - temperature (°F)	96	96	96	96	96	96	96	98	95	96
Growing season (days)	268	234	230	275	277	254	273	229	270	258

TABLE CA-2

CAPCO HYDROLOGIC CHARACTERISTICS

TWDB Quadrangle*	Counties Within Quadrangle	Annual Average Gross Lake Surface Evaporation Rate in Inches	Annual Net Reservoir Evaporation Rate in Feet
F-9	Burnet	73.58	3.9
G-9	Llano, Burnet, Blanco, Hays, Williamson, Travis	67.27	3.32
G-10	Williamson, Travis, Hays, Bastrop, Lee, Fayette	61.88	2.65
G-11	Lee, Fayette	54.58	1.86
H-9	Blanco, Hays	64.54	3.18
H-10	Hays, Bastrop, Caldwell, Fayette	58.69	2.46
H-11	Fayette	54.04	1.07

** Texas Water Development Board Report 64 "Monthly Reservoir Evaporation Rates for Texas 1940 Through 1965," October 1967.*

Population Analysis.

The population projections for use in this study were furnished by the TWDB for each county and for the major population centers within the counties. This includes the City of Austin and most of the non-metropolitan areas not located adjacent to the Highland Lakes. For those communities and towns located adjacent to the Highland Lakes, no population projections were available from the TWDB. However, population data for these areas were included in "The Highland Lakes System Comprehensive Wastewater Study 1970 - 1990," prepared by Freese, Nichols and Endress, Consulting Engineers, July 1970 (referred to hereinafter as "The Highland Lakes Report").

The Highland Lakes Report population projections are used extensively in these areas. Since the projections in this report only cover the period 1970 to 1990, an extension of the plotted data was made to obtain a projection for year 2020. Several of the larger lakeside developments have had preliminary engineering reports prepared which contain population data and/or population projections which were used in lieu of the Highland Lakes Report projections.

Table CA-3 on the following pages shows the population projections for the counties and the cities within the CAPCO region and gives an indication of the cities and communities that have sewage treatment plants at the time this report was prepared. Projections for Caldwell and Williamson counties were omitted from the list because only a small portion of these counties is located within the Colorado River Basin, and there are no communities within the portions of these counties that lie within the Basin. Specific discussion of the population is presented below by county, again excluding Caldwell and Williamson counties.

Bastrop County.

Bastrop County, like many predominantly rural, non-metropolitan counties in Texas, has experienced a general declining trend in its population since 1920. In that year, the population of Bastrop County was 26,649. During the next fifty years, the County population declined by more than one-third to 17,297 in 1970. Elgin, which is on a major transportation route between Austin and Houston, is now the County's largest city with 3,832 people in 1970. Smithville, once the largest city in Bastrop County, has declined slightly from a peak population in 1950, possibly because of the decline in importance of the railroads.

More than 57 percent of the population of Bastrop County lives in the three incorporated cities of Bastrop, Elgin, and Smithville. The remainder live in rural communities or on farms. In contrast, only about 20 percent of the population of the State of Texas live in a rural environment.

Births in Bastrop County have been on the decline since their peak in the mid and late 1940's. By contrast, the number of deaths in the

TABLE CA-3

POPULATION PROJECTIONS

County	City	Existing Treatment Facilities	Population 1970	1980	1990	2000	2010	2020
Bastrop			16,859	17,990	19,290	20,320	21,050	21,830
	Bastrop	Yes	3,112	3,470	3,930	4,340	4,780	5,210
	Elgin	Yes	3,832	4,360	4,940	5,480	6,070	6,650
	McDade		300	290	280	260	220	190
	Smithville	Yes	2,959	3,490	4,010	4,500	5,030	5,570
	Other		6,656	6,380	6,130	5,740	4,950	4,210
Blanco			1,840	1,800	1,800	1,750	1,750	1,650
	Johnson City	Yes	767	830	900	940	1,010	1,030
	Other		1,073	970	900	810	740	620
Burnet			8,991	9,450	10,000	10,470	10,790	11,100
	Burnet	Yes	2,864	3,200	3,620	4,040	4,450	4,890
	Granite Shoals		342	330	330	330	330	320
	Marble Falls	Yes	2,209	2,260	2,300	2,320	2,290	2,240
	Other		3,576	3,660	3,750	3,780	3,720	3,650
Fayette			11,289	9,800	8,460	7,240	6,140	5,250
	Carmine		510	410	340	270	210	160
	Ellinger	Yes	200	160	130	100	80	60
	Fayetteville	Yes	400	330	270	210	170	130
	LaGrange	Yes	3,092	3,130	3,040	2,890	2,710	2,590
	Other		7,087	5,770	4,680	3,770	2,970	2,310
Hays			2,520	2,760	3,070	3,390	3,530	3,590
	Buda	Yes	498	550	610	680	710	720
	Dripping Springs		495	550	610	680	710	720
	Other		1,527	1,660	1,850	2,030	2,110	2,150

TABLE CA-3 (Cont'd.)

County	City	Existing Treatment Facilities	Population 1970	1980	1990	2000	2010	2020
Lee			3,006	3,000	2,940	2,760	2,630	2,470
	Giddings	Yes	2,088	2,250	2,330	2,250	2,250	2,180
	Other		918	750	610	510	380	290
Llano			6,979	7,800	8,800	9,700	10,700	11,600
	Kingsland		1,262	1,400	1,580	1,730	1,900	2,050
	Llano	Yes	2,608	2,960	3,360	3,730	4,140	4,520
	Sunrise Beach		802	870	980	1,080	1,180	1,270
	Other		2,307	3,440	2,880	3,160	3,480	3,760
Travis			295,431	383,190	498,670	639,040	812,710	1,026,580
	Austin	Yes	251,808	326,880	429,920	556,360	714,950	912,110
	Del Valle		300	390	480	580	680	810
	Elroy		125	170	210	250	290	340
	Jonestown		1,190	1,380	1,650	1,800	1,900	2,000
	Lago Vista	Yes	88	4,500	11,230	16,370	24,750	33,000
	Lakeway	Yes	730	5,000	9,300	13,600	17,900	21,890
	Manor	Yes	940	1,180	1,440	1,740	2,050	2,400
	Oak Hill		425	560	690	830	980	1,490
	Pflugerville		549	730	890	1,070	1,270	1,370
	Point Venture	Yes	400	2,000	2,660	3,200	3,700	4,200
	Rolling Wood		780	1,010	1,240	1,490	1,760	2,060
	Sunset Valley		292	390	480	580	680	800
	West Lake Hills		1,488	1,910	2,340	2,810	3,320	3,890
	Other		36,316	37,090	36,140	38,360	38,480	40,220

County has remained fairly stable. Over the last thirty years, the County has shown a net emigration for each decade back to the 1940-1950 period. However, for the decade ending in 1970, a net emigration of only 122 persons was shown; so possibly this trend has been stopped and may be reversed by the attraction of the area for weekend, vacation, and retirement homes.

Blanco County.

Blanco County has experienced a general decline in population from 4,264 in 1940 to 3,515 in 1970. The County's major city, Johnson City, has remained fairly constant over this period, with only a slight increase in population from 648 in 1950 to 767 in 1970. Approximately 60 percent of the County population is located within the Basin, and Johnson City accounts for about 37 percent of this amount. The remainder of the population lives in rural areas.

Although the population of Johnson City is projected to almost double during the study period, Blanco County is projected to continue to decline in population. This will probably be brought about by the younger people migrating to the nearby and larger cities, with the remainder of the population being comprised mostly of older people in retirement. Therefore, there should be an increase in the average age of the County.

Burnet County.

Burnet County has shown a fairly constant population during the past eighty years. The population declined from 10,356 in 1950, to 9,265 in 1960, but has increased to 11,420 in 1970. This increasing trend is expected to continue over the study period due mainly to the proximity of Lakes Buchanan, Inks, Marble Falls, Lyndon B. Johnson, and a small part of Lake Travis to the County. The major cities of Burnet and Marble Falls comprised about 44 percent of the total County population in 1970. Although Marble Falls is projected to remain fairly constant over the study period, Burnet's population is expected to increase by more than 60 percent. Therefore, people moving into the County will probably settle either near the lakes or in Burnet. Burnet will offer appeal to those seeking permanent homes for retirement because of its hospital and the availability of medical services, in addition to its close proximity to the lakes.

According to the Highland Lakes Report, the major problem in the residential areas surrounding the City of Marble Falls is one of sanitation. The underlay of granite rock makes the cost of deep wells almost prohibitive. The absence of central sewage systems makes septic tanks a necessity, and the residents are concerned about pollution of the shallow water well supplies used for each residence.

Fayette County.

Fayette County has experienced a considerable decline in population since the 1930's, and this trend is projected to continue throughout the study period. Most of the decline has come about since the end of World War II. The cities in Fayette County have not declined in proportion to the overall County population, however. Of the three major cities in the County (La Grange, Flatonia, and Schulenburg), La Grange is the only one located within the Colorado River Basin. La Grange showed a constant rise until 1950, with a slight decline between 1950 and 1970. The population projections for La Grange, however, indicate the City will more than double in size over the study period.

The real areas of population decline are the more rural sectors of the County, signifying that this area, like other farming areas, has experienced growing automation of the farming industry. Due to this trend, people moved away from rural farming areas into nearby small cities and later into larger neighboring cities as the economy made a transition from a rural to an urban orientation.

Hays County.

Hays County has experienced a considerable increase in population since the 1930's, with an increase of approximately 40 percent between 1960 and 1970. The population of the County is projected to increase by 20€ percent over the study period. Since the major cities in Hays County are not within the Colorado River Basin, the significant growth of the County will occur outside of the study area. The two communities of any significance in the study area are Buda and Dripping Springs. These communities are expected to have only a moderate increase in population over the study period.

The geographical location of Buda makes it an attractive suburb for the larger cities of Austin and San Marcos, and this proximity will be the major contributing factor to its growth. Dripping Springs is located on a main highway at the lower end of the Highland Lakes chain and in the center of excellent ranch land. This community will appeal to persons who prefer small ranches to the country club atmosphere of most of the lakeside developments along the Highland Lakes.

Lee County.

Lee County has experienced a continual decline in population since the 1920's, to a figure of 8,048 in 1970. During most of this period, however, the population of the two larger incorporated cities of Giddings and Lexington increased. Between 1960 and 1970, the population of Giddings declined slightly and Lexington leveled off.

Giddings is the only city located within the study area in Lee County and although Lee County is expected to continue to decline in population,

the population of Giddings is expected to more than double during the study period.

Llano County.

The population of Llano County remained fairly constant between 1920 and 1960, and increased approximately 33 percent between 1960 and 1970. The County is projected to continue a moderate increase in population over the study period with an increase of about 66 percent between 1970 and 2020. This growth will be due mainly to the residential developments along Lakes Lyndon B. Johnson, Inks, and Buchanan.

The two largest communities in the study area are the City of Llano and the unincorporated community of Kingsland. However, only a slight increase in population is projected for both during the study period. The greatest population increase in the County is expected along the shore of Lake Lyndon B. Johnson. Sanitation problems along the the lake are causing concern among the residents, particularly in Kingsland, where a condition exists similar to the one reported for Marble Falls--close spacing of septic tank systems and shallow water wells.

Travis County.

Travis County has experienced consistent growth in population throughout its history since 1850. The main reason for this growth is the City of Austin, which is the largest of the metropolitan areas within the Colorado River Basin. Both the City and County have experienced constant population growth even during periods of economic depression.

The greatest numerical growth for Austin and Travis County occurred from 1950 to 1960, when the population increased by just over 54,000 and 51,000 respectively. The main growth of the County and City has been the result of people moving into the area from outside Travis County.

Both the City of Austin and Travis County are expected to undergo tremendous population growth during the study period. This is mainly due to the diversified economy, which includes State and Federal governmental activities, institutions of higher education, and military installations. The major expected increase in population outside the metropolitan area of Austin will occur adjacent to Lake Travis, where numerous lakeside developments are in existence and are projected to attract substantial numbers of new residents. The satellite cities surrounding Austin are also projected to have substantial increases in population due to the desire to live outside the city proper.

Hydrology.

Surface Water.

The Colorado River runs through the center of the CAPCO region from west to east for a distance of approximately 280 river miles. The Fayette-Colorado county line crosses the Colorado River at approximately river mile 157 in the lower portion of the region, and the Llano-San Saba county line comes to a point in the upper reach of Lake Buchanan at approximately river mile 434. The drainage area of the Colorado River is approximately 40,880 square miles at the Fayette-Colorado county line and approximately 31,040 square miles at the Llano-San Saba county line.

Two major streams have their confluence with the Colorado River within the CAPCO region: the Pedernales River (drainage area approximately 1,000 square miles) with its confluence at river mile 355 on the Colorado River, and the Llano River (drainage area approximately 4,300 square miles) with its confluence at river mile 400 on the Colorado River.

A system of large reservoirs has been constructed on the Colorado River within the CAPCO region and is known as the Highland Lakes. The Highland Lakes were created primarily for the prevention of disastrous floods which had ravished Austin and cities and communities within the valley of the Colorado River below Austin. Twenty-two serious floods were recorded at Austin between 1843 and 1938. The floods which occurred between 1900 and 1938 were estimated to cause a total of over $85 million damage.

In addition to the flood prevention need, the City of Austin wanted a dependable source of municipal water, rice growers on the coast wanted a steady supply of irrigation water, an inexpensive source of electrical power was desired, and governmental agencies were looking for work projects to relieve the heavy unemployment that was part of the great depression of the 1930's. Soil conservation, reforestation, and wild life preservation are also important benefits of the development of the Highland Lakes. In 1934, legislature of the State of Texas created the Lower Colorado River Authority (LCRA) with the following functions designed to fulfill the above functions of the Highland Lakes: storage, distribution, and sale of water; generation and sale of electricity; flood control; and reforestation and soil conservation. Tables CA-4 and CA-5 provide a summary description of each of the six Highland Lakes.

A number of USGS streamflow gaging stations are located within the CAPCO region on the Colorado River and its tributaries. Three long-term streamflow gaging stations on the Colorado River give an indication of the magnitude and variation of the runoff and resulting flows within the region. The gaging station near San Saba in San Saba County, located approximately 45 river miles above the CAPCO

TABLE CA-4

LOWER COLORADO RIVER AUTHORITY
DAMS ON THE COLORADO RIVER

Dam	Lake	Date Completed	Spillway Crest Elevation*	Height of Dam (feet)	Length of Dam (feet)
Buchanan	Buchanan	1938	1,020.5	145.5	10,987.0
Inks	Inks	1938	888.5	96.5	1,547.5
Alvin J. Wirtz	Lyndon B. Johnson	1951	796.0	118.3	5,491.4
Max Starke	Marble Falls	1951	725.0	98.8	860.0
Mansfield	Travis	1942	714.1	266.0	7,098.0
Tom Miller**	Austin	1939	492.8	85.0	1,590.0

**Feet above mean sea level.*

***Tom Miller Dam and Lake Austin are operated as part of the LCRA System under contract with the City of Austin.*

Source: *Texas Water Development Board Report 126, Engineering Data on Dams and Reservoirs in Texas, Part III, February, 1971.*

TABLE CA-5
HIGHLAND LAKES DATA

Lake	Surface Area at Spillway Level (acres)	Approximate Length (miles)	Approximate Maximum Width (miles)	Total Capacity (acre-feet)
Buchanan	23,060	20	5.0	992,000
Inks	803	4	0.6	17,540
Lyndon B. Johnson	6,375	21	1.3	138,500
Marble Falls	780	6	0.2	8,760
Travis	29,000*	65	1.5	1,954,000**
Austin	1,830	20	0.2	21,000
Totals	61,848	136		3,131,800

**Surface area at 714.1; area at 681 is 18,930 acres.*

***At 714.1*

region, had an average annual runoff of 999,100 acre-feet from a contributing drainage area of 18,700 square miles during the 46 years 1917-1919, 1921-1922, and 1924-1964. The maximum year of runoff was 1938 with 2,809,000 acre-feet, and the minimum year was 1917 with 314,000 acre-feet.

The Colorado River streamflow gaging station at Austin (08158000), during the 66 years 1899-1964, had an average annual runoff of 1,780,000 acre-feet from a contributing drainage area of 26,500 square miles. The maximum year of runoff was 1914 with 5,450,000 acre-feet, and the minimum year 1917 with 427,000 acre-feet. The flow at Austin is affected by the storage reservoirs above San Saba which have a combined conservation storage capacity of 490,540 acre-feet, and the six major reservoirs (The Highland Lakes) between San Saba and Austin. The total initial conservation storage capacity of the Highland Lakes is 2,262,000 acre-feet. The total initial conservation storage capacity in major reservoirs above Austin in 1964 was 3,067,000 acre-feet.

The Colorado River at the streamflow gaging station at Columbus, Colorado County, during the 48 years 1917-1964 had an average annual runoff of 2,404,000 acre-feet from a contributing drainage area of 29,170 square miles. This gaging station is located approximately 10 river miles below the CAPCO area. The maximum year of runoff was 1919 with 6,660,000 acre-feet, and the minimum year was 1917 with 472,000 acre-feet. The flow at Columbus has also been affected by the storage in reservoirs above Austin, as mentioned above. Flow at both Austin and Columbus has been sustained during the years since 1940 by releases from the reservoirs above Austin.

Figure 1 shows a flow-duration curve for the period 1915-1969 for the gaging station at Austin, located at river mile 290.3 approximately 1.4 miles downstream from Town Lake. As an example, if the water demand for the City of Austin was 82,000,000 gallons per day (127 cfs), which is the present combined design capacity of its three water treatment plants, this flow should occur in the river more than 95 percent of the time. None of this flow is a result of sewage effluent from the City of Austin, since all city wastewater treatment plant effluents enter the Colorado River below this gaging station.

Ground Water

The aquifers, or water-bearing formations, within the State are classified on a statewide basis as major and minor water-bearing formations. Major aquifers are defined as those capable of supplying large quantities of water over a large area of the State. The major aquifers of the CAPCO region within the Colorado River Basin are the Trinity Group Aquifer, Carrizo-Wilcox Aquifer, Edwards (Balcones Fault Zone) Aquifer, and Gulf Coast Aquifer. The minor aquifers within the CAPCO region are the Ellenburger-San Saba Aquifer, Hickory Aquifer, Queen City Aquifer, and Sparta Aquifer. A brief description of these aquifers follows.

Trinity Group Aquifer.

The Trinity Group Aquifer extends over a large area of North and Central Texas. It ranges from only a few feet in thickness along the western edge of the aquifer to more than 1,200 feet in the eastern part of the aquifer. Yields of large-capacity wells in the aquifer range up to several thousand gallons per minute, but in thinner sections of the aquifer, where the aquifer supplies water principally for irrigation and domestic use, most wells yield less than 100 gallons per minute. Concentrations of dissolved solids generally do not exceed 500 mg/l throughout the western portion of the aquifer. Towards the east, where the water-bearing zones become deeply buried, usable water quality occurs to a depth of about 3,500 feet.

Carrizo-Wilcox Aquifer.

The Carrizo-Wilcox Aquifer is one of the most extensive aquifers in Texas, extending from the Rio Grande northeastward into Arkansas and Louisiana. The aquifer is exposed at the surface along its northern and western edge where it is recharged by precipitation and streams crossing the outcrop areas. The thickness of the acquifer ranges from a few feet in the outcrop areas to more than 3,000 feet in the lower areas.

Ground water in the aquifer is generally under artesian head down-dip from the outcrop, and flowing wells are common in areas of low elevation. In heavily pumped areas, however, water levels have declined and pumping costs have correspondingly increased. Yields of wells vary widely, but yields of more than 1,000 gallons per minute from large capacity wells are common. Usable quality water occurs at greater depths (up to 5,300 feet) than any other aquifer in the State.

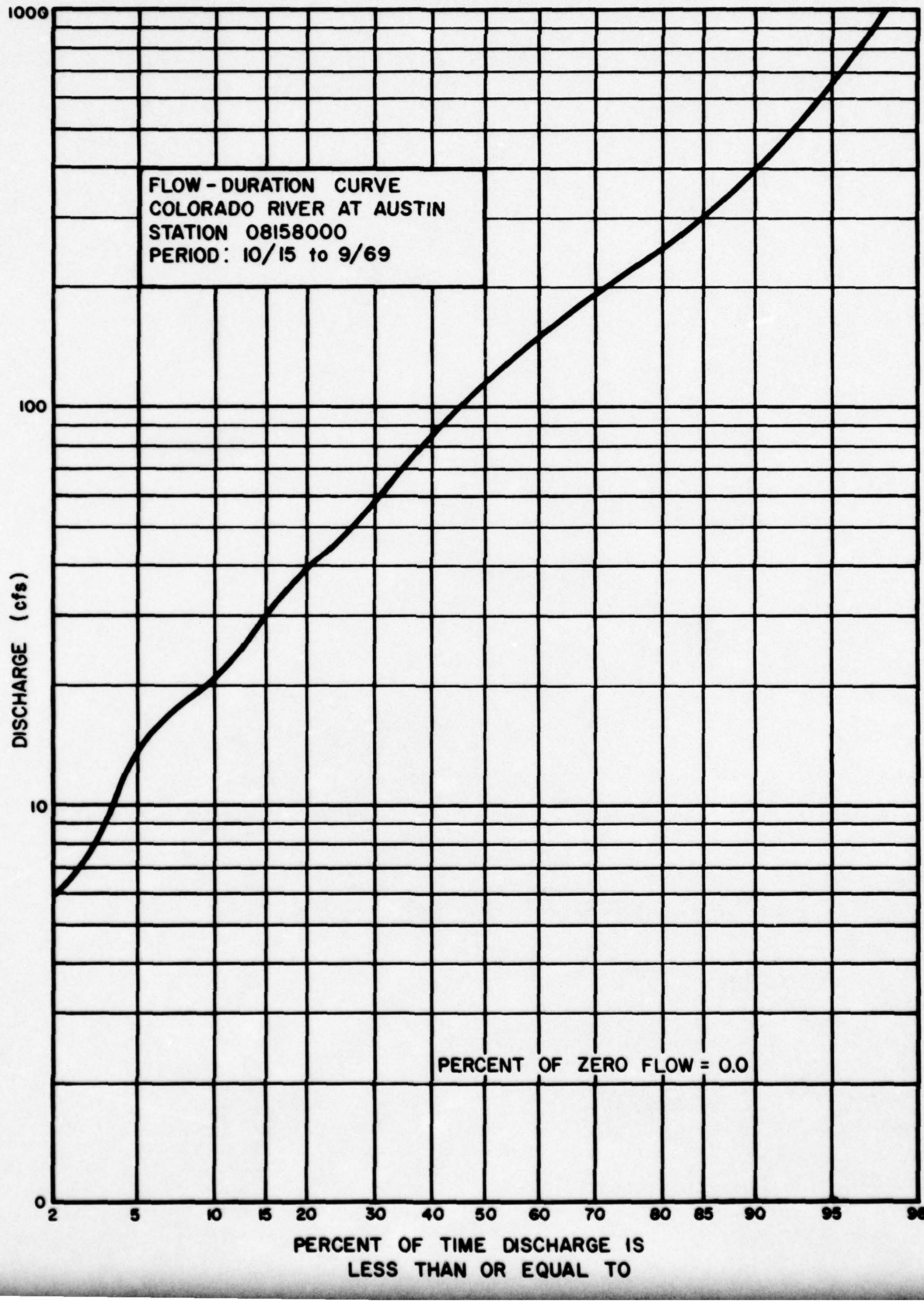
Edwards (Balcones Fault Zone) Aquifer.

This aquifer extends from central Kinney County east and north-east into southern Bell County. It includes the Edwards Limestone and associated limestone beds of Cretaceous age. Municipal and industrial water is supplied to numerous cities and towns by the aquifer, including the total municipal water supply for the City of San Antonio. Capacities of wells operated by this City are among the largest in the world, with some yielding over 16,000 gallons per minute each. The water contains principally calcium, magnesium and bicarbonate, and consequently is hard. Some of the largest springs in the State result from natural discharge of ground water from the aquifer. These include Leona Springs at Uvalde, San Pedro Springs at San Antonio, Comal Springs at New Braunfels, San Marcos Springs at San Marcos, and Barton Springs at Austin.

Gulf Coast Aquifer.

The Gulf Coast Aquifer covers most of the Coastal Plain from the Lower Rio Grande Valley northeastward into Louisiana, extending

FIGURE 1


FLOW - DURATION CURVE
COLORADO RIVER AT AUSTIN
STATION 08158000
PERIOD: 10/15 to 9/69
PERCENT OF ZERO FLOW = 0.0
DISCHARGE (cfs)
1000
100
10
0
2
5
10
15
20
30
40
50
60
70
80
85
90
95
98
PERCENT OF TIME DISCHARGE IS
LESS THAN OR EQUAL TO

about 100 miles inland from the Gulf. Fresh water occurs in the aquifer to depths of more than 3,000 feet, and tremendous quantities of water are pumped for municipal, industrial, and irrigation use. Large capacity wells may yield as much as 4,500 gallons per minute in some areas.

Throughout most of the eastern part of the aquifer the ground water is low in dissolved solids, generally less than 500 mg/l. Sodium and bicarbonate are commonly the principal constituents, and the water is comparatively soft. The presence of iron and dissolved gasses in some areas require local pretreatment prior to use.

Ellenburger-San Saba Aquifer.

This aquifer yields water for domestic, industrial, and minor irrigation supplies in the middle Colorado River Basin. The formations are exposed at the surface within a circular area surrounding the Llano Uplift where it is recharged by precipitation and streams crossing the outcrop. The aquifer reaches a thickness of more than 1,000 feet. Ground water occurring in the aquifer is commonly under artesian head. Natural discharge by springs supports the base flows of streams, including the Llano, San Saba, Pedernales, and the main stem of the Colorado River. Yields of wells range to as much as 1,000 gallons per minute. In most places the water is low in dissolved solids, but comparatively hard.

Hickory Aquifer.

The Hickory Aquifer underlies the Ellenburger-San Saba Aquifer in the Llano Uplift region and furnishes most of the ground water in this area. The aquifer is made up principally of sand and sandstone and ranges up to 400 feet in thickness. Yields of wells generally range between 200 and 500 gallons per minute, although a few wells have yielded more than 1,000 gallons per minute. Irrigation within the area as well as municipal needs for the communities of Mason, Brady, Melvin, and Eden is supplied by water from the Hickory Aquifer. Dissolved solids concentrations of water in the aquifer range from about 300 to 500 mg/l.

Queen City Aquifer.

The Queen City Aquifer extends southeast into Louisiana. The aquifer consists chiefly of sand and loosely-cemented sandstone. It is exposed at the surface throughout most of its extent in northeast Texas. The aquifer supplies water for domestic, livestock, municipal, and industrial use in East Texas and provides irrigation supplies in Wilson County. Yields of wells are generally low, with few exceeding 400 gallons per minute. Concentrations of dissolved solids are generally low; however, throughout part of northeast Texas the water is acidic and contains excessive amounts of iron.

TABLE CA-6

PROJECTED MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

(MGD)

County	City	1970	1980	1990	2020
Bastrop	Bastrop				
	Municipal	0.52	0.62	0.72	1.04
	Industrial	–	–	–	–
	Elgin				
	Municipal	0.58	0.79	0.95	1.60
	Industrial	–	–	–	–
	Smithville				
	Municipal	0.32	0.42	0.50	0.77
	Industrial	–	–	–	–
Blanco	Johnson City				
	Municipal	0.11	0.13	0.16	0.21
	Industrial	–	–	–	–
Burnet	Burnet				
	Municipal	0.43	0.52	0.60	0.90
	Industrial	–	–	–	–
Fayette	La Grange				
	Municipal	0.43	0.46	0.46	0.44
	Industrial				
Lee	Giddings				
	Municipal	0.50	0.60	0.66	0.72
	Industrial	–	–	–	–
Llano	Llano				
	Municipal	0.64	0.77	0.90	1.30
	Industrial	–	–	–	–
Travis	Austin				
	Municipal	44.59	61.24	82.67	190.15
	Industrial	2.72	3.44	3.88	5.56

Sparta Aquifer.

The Sparta Aquifer underlies the Queen City Aquifer and extends from southeastern Wilson County northeastward to Sabine County. The aquifer generally consists of sand beds, and ranges in thickness to 300 feet. The aquifer supplies water to numerous towns, cities, institutions, irrigated areas, several industries, and domestic and livestock supplies. Large capacity wells generally yield 400 to 500 gallons per minute and some as much as 1,200 gallons per minute. Water in the aquifer is generally low in concentrations of dissolved solids.

Water Use Projections.

Basic municipal and industrial water use projections for the Colorado River Basin were developed by the TWDB for use in the Texas Water Plan and have been modified and furnished by this agency for use in the Colorado River Basin study. For the purpose of this study, historical municipal water use, municipal use projections, and the sum of the municipal and industrial water use projections, where distinguishable, were compiled for most of the major cities in the Basin, and those within the CAPCO region are shown on Table CA-6. For some of the cities, however, the industrial requirement is so minimal that the municipal plus industrial is almost coincident with the municipal requirement.

A tabulation of the historical surface water use for irrigation by county for the years 1958, 1964, and 1969 is presented in Table CA-7. These values indicate the possibility for substitution of disinfected secondary effluent for irrigation water currently removed from the surface resource.

TABLE CA-7

HISTORICAL SURFACE WATER IRRIGATION USE

Irrigation Usage (acre-feet)

County	1958	1964	1969
Bastrop	1,065	1,929	1,409
Blanco	25	78	0
Burnet	313	1,026	1,014
Caldwell	0	0	0
Fayette	2,705	1,315	900
Hays	56	432	117
Lee	0	0	0
Llano	0	328	634
Travis	980	814	1,510
Williamson	0	0	0

Existing Industrial and Agricultural Operations.

The existing waste-producing industries and agricultural operations within the CAPCO region are presented below. The listing of these facilities was obtained from the TWQB. Information presented herein was derived from discharge permits, certificates of registration, and from the Highland Lakes Report, which utilized field surveys and personal interviews of industry personnel. There are a number of industries within the city limits of Austin for which there are no-discharge permits and which are not presented below. These industries discharge into the municipal wastewater collection system and are discussed in the Austin Metropolitan section of this report. A brief description of the industries, which are listed in alphabetical order, follows:

City of Austin (Holly Street Power Plant).

The Holly Street Plant is located at 2400 Holly Street in Austin. The plant uses once-through cooling water obtained from the lower end of Town Lake approximately 1,800 feet above Longhorn Dam. The TWQB discharge permit (No. 10543-06) allows a not-to-exceed discharge of an average of 435,240,000 gallons per day and a maximum not-to-exceed 580,320,000 gallons per day, or 403,000 gallons per minute. Temperature requirements for the discharge on a not-to-exceed basis are: monthly average of 96°F, 24-hour daily composite of 98°F, and individual sample of 101°F.

City of Austin (Seaholm Power Plant).

The Seaholm Power Plant is located at 800 West 1st Street in Austin. The plant uses once-through cooling water obtained from Town Lake upstream from the mouth of Shoal Creek. The discharge is into Shoal Creek adjacent to the plant, thence into Town Lake. A jetty in Town Lake forms a channel which diverts the natural flow in Shoal Creek, and the cooling water returns to a point approximately 600 feet downstream from the mouth of Shoal Creek. The TWQB discharge permit (No. 10543-05) allows a not-to-exceed average discharge of 106,600,000 gallons per day with the quality to be current Colorado River water at Austin, Texas. Temperature rise of the water is not to exceed 7°F.

Bergstrom Air Force Base.

Bergstrom Air Force Base is located southeast of Austin, just south of S.H. 71. The industrial wastewater produced at the site consists of aircraft washwater containing cleaning solution and dirt. The facility does not have a flow meter; however, the Base Engineers estimate the volume to be approximately 6,000 gallons per day. The industrial wastewater is presently discharged from a storm sewer outlet into an open ditch leading to Onion Creek, thence into the Colorado River. A current military construction project will collect all wastes from the washracks, separate oils and grease, and dispose of the wastewater into the sanitary sewer.

Domestic wastewater from the base is discharged directly into the City of Austin collection system.

Bracewell, Ernest W. (Southside Market).

This is a meat processing operation located immediately east of F.M. 1704, four miles west of the intersection of F.M. 696 and U.S. 290, one mile south of the city limits of Elgin, Texas, in Bastrop County.

Wastewater consists of runoff from a holding pen area and washdown from the slaughterhouse. The wastewater is routed through a grease trap and blood trap (each having a capacity of 15 cubic feet) and is discharged through a clay pipe drain into a retention pond having 2,800 cubic feet of capacity. Liquid waste from the pond is disposed of by irrigation of 11 acres of pastureland on an irregular basis.

The TWQB certificate of registration for this meat processing operation (No. 20168) allows a volume of wastewater to enter the pond not to exceed an average of 1,000 gallons per day, a maximum of 2,000 gallons per day, or a maximum of 40 gallons per minute. The slaughterhouse and disposal area are located in the drainage area of an unnamed creek in Bastrop County which flows into Little Sandy Creek, thence into Big Sandy Creek, thence into the Colorado River. No discharge into or adjacent to any water *in the State* is authorized by the certificate of registration, although the irrigation practice is allowed provided that it is designed and managed to prevent contamination of ground or surface waters and to prevent the occurrence of nuisance conditions in the area.

Capital Aggregates (Concrete Plants).

The Capital Aggregates Company's TWQB permit (No. 00486) covers the wastewater discharged from two operations located at the same site adjacent to the City of Austin Govalle sewage treatment plant. One plant produced asphaltic concrete and the other produced ready-mix concrete. However, both plants have been shut down, with operations moved to a new plant at 1001 Ed Bluestein Blvd. This new plant will have no discharge of wastewater; all effluent will be contained in pits with water returning to the Colorado River by percolation through sand deposits under the pits.

Capital Aggregates (Sand and Gravel).

This operation was a sand and gravel crushing plant located just below Longhorn Dam in Austin. However, this operation has been shut down at present with the facilities being moved to the new location on Ed Bluestein Blvd. mentioned above. TWQB permit (No. 00487) applies to the sand and gravel plant.

Capital Cattle Company.

This operation consists of a cattle transfer and holding facility having a 40,000 animal capacity. It is located north of F.M. 812 approximately 0.7 miles east of the intersection of F.M. 812 with U.S. 183 at Pilot Knob, Travis County, Texas. Wastewater consists of runoff from approximately 200 acres, including cattle holding pens which drain into a series of three ponds having a total capacity of 175 acre-feet. The collected wastewater is used to irrigate 600 acres of cropland.

The TWQB permit (No. 01734) which covers this operation requires a no-discharge condition except in the event of an eight-inch rainfall which occurs during any 24-hour period. Any discharge from the operation will flow into Onion Creek, thence into the Colorado River.

D and D Feedlot (Cattle Production).

This facility consists of cattle feedlot and swine feedlot operations on an approximately 23.3-acre feeding area. The cattle feedlot has a capacity of 4,000 head, and the swine feedlot has a 1,300-head capacity. The operations are located approximately 1.5 miles north of the intersection of F.M. 448 with F.M. 2239 and approximately 3.5 miles south of U.S. 290 at a point four miles southwest of the City of Giddings in Lee County, Texas. Wastewater consists of runoff from the feedlot area which is diverted into a rentention pond having a capacity of 25.7 acre-feet. The retention capacity of this pond will far exceed the requirement to hold the runoff incident to a 25-year, 24-hour rainfall.

The wastewater collected in the retention facilities is used to irrigate 120 acres of improved grasslands. The irrigation system is sized such that by irrigating 20 hours per day, approximately 12 days would be required to dewater the ponds in the event of the 25-year, 24-hour rainfall. Any discharge resulting from this practice would flow overland to Rabbs Creek, thence into the Colorado River.

Solid waste resulting from the feedlot operations will be spread over 300 acres of farmland and plowed under at the time of application to reduce the possibility of pollution from rainfall runoff. The TWQB permit (No. 01592) covers the feedlot operations and allows a no-discharge except under the conditions described above.

Del Valle Hog Farm.

This operation is a commercial swine farrowing and finishing operation with a 650-head capacity. It is located approximately 2.5 miles southeast of the intersection of F.M. 973 and S.H. 71, five miles southeast of the city limits of Austin in Travis County, Texas.

Wastewater consists of runoff and washing from the swine farrowing and finishing operations. TWQB certificate of registration (No. 20289) for this operation allows an average wastewater flow of 2,000 gallons per

day. The runoff is diverted into a 0.85 acre-foot-capacity retention pond. Liquid waste is disposed of by evaporation and irrigation of 1,000 acres of pastureland and cropland. Solid waste is also disposed of on this 1,000 acres.

Doyle, H.W. Processing Plant (Swine Production).

This operation consists of a commercial swine-processing facility (slaughterhouse and meat packing) located east of U.S. 77 approximately 1.1 miles southeast of the intesection of U.S. 77 with U.S. 290 in the City of Giddings, Lee County, Texas.

Wastewater consists of washdown of the processing areas. Treatment facilities include a blood-recovery system, two 1,500-gallon septic tanks, a three acre-foot evaportion pond, and facilities to irrigate four acres of native Bermuda grass. The TWQB certificate covering these facilities requires a no-discharge condition except by irrigation as described above. Any runoff from this operation would flow into an unnamed creek which flows into Sandy Creek, thence into Rabbs Creek, thence into the Colorado River.

Elgin-Butler Brick Company.

The Elgin-Butler Brick Company owns and operates two structural clay products manufacturing facilites north of Butler, Texas, in Bastrop County, as described below.

Structural Clay Products Plant.

This facility is located approximately two miles north of the intersection of F.M. 696 with U.S. 290 and east of F.M. 696.

Wastewater consists of washdown water typical of washing operations in a clay processing area. The TWQB permit (No. 01414) covering this operation requires a no-discharge condition for the facilities. All effluent is disposed of by evaporation on company-owned property adjacent to the plant site. When evaporation is not adequate to dispose of the washwater, irrigation on five acres is available as an alternative.

Brick and Tile Plant.

This facility is located approximately 1-1/2 miles north of the intersection of F.M. 696 with U.S. 290 and west of F.M. 696.

Wastewater consists of process water typical of clay processing operations. The TWQB permit (No. 00444) covering this operation requires a no-discharge condition. All effluent is disposed of by evaporation on company-owned property adjacent to the plant site. The wastewater is routed to a series of settling tanks which discharge into a concrete tank (10' x 8' x 5'). When the final tank is full, a tank truck transfers the wastewater to a clay-lined pit where it is allowed to evaporate.

Fayette County Swine Breeders, Inc.

This commercial swine-production operation is located north of the MK&T railroad track approximately 1/2 mile north of S.H. 71 and six miles west of the intersection of S.H. 71 with U.S. 77 in La Grange, Fayette County, Texas. It has a capacity of 3,240 animals and includes three completely enclosed farrowing houses and five nurseries. Two open-front buildings are used for feeder hogs. Three of the nurseries are equipped with slatted floors and underground piping. All buildings and the 10 acres of outside facilities drain into five retention ponds having a total capacity of 13.5 acre-feet. A dike was constructed to divert offsite runoff. The average flow from the enclosed facilities will total 6,000 gallons per day. A 25-year, 24-hour rainfall of 8.7 inches falling on the 10 acres will produce 6.2 acre-feet of runoff.

Liquid waste is disposed of by irrigation of 150 acres of pastureland and cropland. Solid wastes are spread over 100 acres of pastureland.

The TWQB certificate (No. 20440) covering this operation requires a no-discharge condition except from the 25-year rainfall. Any discharge that occurs will flow into Wertzner Creek which flows into Baylor Creek, thence into the Colorado River.

Felps, Jerome K. (Swine Production).

This is a commercial swine-production operation with a 1,127-head capacity. It is located 1.3 miles east of U.S. 281 and 1.5 miles south of S.H. 29 approximately 2.5 miles south of the city limits of Burnet, Texas in Burnet County.

Wastewater consists of runoff and washdown from the farrowing houses nursery, and finishing buildings. The TWQB certificate of registration (No. 20062) for this facility requires a no-discharge condition except in the event of rainfall exceeding 7.6 inches in any 24-hour period. If discharge were to occur, it would be into an unnamed creek, which flows into Hamilton Creek, thence into the Colorado River.

The waste disposal system includes five underfloor concrete lagoons (20,000 cubic feet capacity) which serve two farrowing houses, one nursery, and two finishing barns. Overflow from these lagoons is routed to a 3.4 acre-foot holding pond. Outside drainage from six 1/2-acre sow pastures is collected in a three acre-foot holding pond which also collects drainage from ten acres of pens and pastureland. Liquid waste from the two holding ponds is disposed of by evaporation and irrigation of 54 acres of farmland. Solid wastes are spread on 150 acres of farmland.

Hollas, Kenneth (Dairy).

This is a dairy operation with a 75-animal capacity. It is located approximately one mile east of F.M. 155 approximately 3.1 miles north of the City of Weimar in Fayette County, Texas.

Wastewater consists of washdown from covered holding pens and the milking parlor, which is routed to a subsurface concrete liquid manure tank (1,600 cubic foot capacity). The collected wastewater is used to irrigate approximately 70 acres of cropland and 40 acres of Coastal Bermuda grass. Irrigation is accomplished by using a 1,000-gallon-capacity trailer to apply the wastewater at approximately 3,000 gallons per acre. The TWQB permit (No. 01732) covering the operation requires a no-discharge condition, except by irrigation as described above. Any runoff from this operation would flow into Harvey Creek, thence into the Colorado River.

Hopson, A.D. and A.J. (Swine Production).

This operation consists of commercial swine-production facilities with a capacity of 1,625 animals. It is located immediately east of F.M. 2323 at a point 6.5 miles southwest of the city limits of Llano in Llano County.

Wastewater consists of runoff from eight acres of pens and pastureland. This runoff is retained in a pond having a capacity of 3.83 acre-feet. Wastewater is used to irrigate 22 acres of cropland and pastureland, and solid waste is spread over the 22 acres. The TWQB certificate (No. 20294) which covers this operation requires a no-discharge condition except in the event of rainfall exceeding 7.4 inches in any 24-hour period. Should a discharge occur, it would be into an unnamed creek which flow into Six Mile Creek, thence into the Llano River, thence into the Colorado River.

Lawson, Noel G. (Swine Production).

This operation is a commercial swine-production facility with a 26-animal capacity. It is located immediately west of Nuckles Crossing Road approximately 0.5 mile south of East St. Elmo Road and approximately 1.7 miles southeast of the intersection of East St. Elmo Road and I.H. 35 in Travis County.

Wastewater consists of liquid wastes from swine-farrowing operations. Farrowing house wastewater flows to a system including a covered 1,600-gallon sludge trap, a 1,600-gallon septic tank, and soil absorption system with 250 feet of lateral drain lines. Sludge is spread on adjacent farmland. The TWQB certificate (No. 2009) covering this operation requires a no-discharge condition for the facilities, which are located in the drainage area of an unnamed creek which flows into Williamson Creek, thence into Onion Creek, thence into the Colorado River.

Lone Star Industries, Inc. (Limestone Plant).

This opertion consists of a limestone processing plant located approximately 1/2 mile east of U.S. 281 and approximately three miles south of the City of Burnet in Burnet County.

Wastewater consists of washwater from a limestone quarry and crushing operation. This wastewater flow is measured and collected in retention

facilities consisting of two earthen ponds with a total capacity of 2.9 million gallons. The TWQB permit (No. 00641) which covers these facilities allows a not-to-exceed average of 360,000 gallons per day, a not-to-exceed maximum of 500,000 gallons per day, or 1,000 gallons per minute. Effluent quality parameters are presented below. The point of discharge of the effluent is into Delaware Creek, adjacent to the plant site, thence into Hamilton Creek, thence into Lake Travis.

EFFLUENT QUALITY PARAMETERS

Parameter	Monthly Average (Not to Exceed)	24-Hour Daily Composite (Not to Exceed)	Individual Sample (Not to Exceed)
TSS (mg/l)	20	25	30
Settleable Material (mg/l)	5	6	7
Debris	- None of industrial, sewage, or other man-made origin.		
Toxic Compounds	- None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life.		
Foaming or Frothing Material	- None in such amount that will cause foaming or frothing of a persistent nature in receiving waters.		

Long and Pittman (Swine Production).

This operation consists of a commercial swine-production facility with a 740-animal capacity. It is located 1/2 mile west of S.H. 95 immediately southeast of a county road which intersects S.H. 95 approximately 1/8 mile north of its intersection with F.M. 1441 and approximately four miles north of downtown Bastrop in Bastrop County, Texas.

Wastewater consists of runoff from a swine farrowing and feedlot operation. The runoff from the feeding pens, weaning pens, and farrowing house is collected in retention ponds. The wastewater is disposed of by evaporation and irrigation of 12 acres of Bermuda grass. The sludge is spread on a maximum of 7.9 acres at a rate of two tons per acre.

The TWQB certificate (No. 20123) which covers this operation calls for a no-discharge condition except in the event of rainfall exceeding 8.3 inches in any 24-hour period. Any discharge from the facilities would flow into an unnamed creek which flows into Piney Creek, thence into the Colorado River.

Longhorn Sand and Gravel, Inc.

This sand and gravel operation is located on F.M. 973 between F.M. 969 and S.H. 71 in Travis County, Texas. Wastewater consists of wash-water from screening operations which flows into a pit on company-controlled property. TWQB permit (No. 00775) which covers this operation allows a volume of 20,000 gallons per day, six days per week. Discharge of wastewater from the pit is by percolation through the bottom into the Colorado River.

Lower Colorado River Authority (Power Plant).

This electric power generating plant (steam) is located on the south shore of Lake Lyndon B. Johnson at a point approximately seven miles west of U.S. 281 on S.H. 71, 3-1/2 miles north of F.M. 2147. Wastewater consists of cooling water with 5,250 gallons of secondary treated sanitary waste effluent per day. The TWQB (No. 01369) which covers the plant allows an average volume of 821,500,000 gallons per day, and a maximum of 571,000 gallons per minute. Effluent quality parameters are presented below. Effluent is discharged into Lake Lyndon B. Johnson adjacent to the plant site in Llano County, Texas.

EFFLUENT QUALITY PARAMETERS

	(Not to Exceed)		
Item	Monthly Average	24-Hour Daily Composite	Individual Sample
pH (Max. & Min.)	6.2-8.5	6.0-9.0	5.5-9.5
Total Residue (mg/l)	10.0*	12.0	15.0
Chlorides (mg/l)	5.0*	10.0	10.0
Sulphates (mg/l)	5.0*	10.0	10.0
Total Suspended Solids (mg/l)	1.0*	1.0	2.0
Volatile Suspended Solids (mg/l)	1.0*	1.0	2.0
Settleable Matter (mg/l)	1.0*	1.0	2.0
Biochemical Oxygen Demand (mg/l)	(1.0)*	(1.0)	(1.0)
Chemical Oxygen Demand (mg/l)	(1.0)*	(1.0)	(1.0)

Oil and Grease (mg/l)	None *	None	None
Color (units)	None*	None	None
Temperature (°F)	98	106	110
Dissolved Oxygen mg/l (minimum)	4.0	4.0	4.0

*The values for all items marked with an asterisk represent increases over intake water quality.

Temperature	-	Not to exceed the water quality requirements for this section of the Colorado River as required by the Water Quality Criteria established by the State of Texas. The temperature increase through the plant shall not exceed 15° F from intake to outlet.
Debris	-	None of industrial, sewage, or other man-made origin.
Toxic Compounds	-	None in such amounts that will cause the receiving water to be toxic to human, animal, or aquatic life.
Foaming or Frothing Material	-	None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

Moss, Edgar J. (Swine Production).

This operation consists of a commercial swine-production facility with a 710-animal capacity. It is located immediately south of a county road 1-1/2 miles east of the intersection of S.H. 16 and F.M. 965, approximately 15 miles south of Llano, Texas. Wastewater consists of runoff from a swine feedlot, which is retained in two ponds having a total capacity of 7.78 acre-feet. Liquid waste is disposed of by irrigation of 10 acres of pastureland, and solid wastes are disposed of on 500 acres of rangeland. The TWQB certificate (No. 20035) covering this operation requires a no-discharge condition for the facilities. Any runoff from the irrigation operation would flow into Sandy Creek, thence into Lake Lyndon B. Johnson.

Rabb, Sam (Swine Production).

This operation consists of a commercial swine-production facility having a capacity of 450 animals. It is located north of S.H.71 approximately three miles northwest of the intersection of S.H. 71 with S.H. 29 and approximately five miles northwest of the City of Llano in Llano County, Texas.

Feeder pens are located in two separate areas totaling 18-1/2 acres. Runoff from these pens and from the farrowing house is evenly distributed by spreader dams over 200 acres of pastureland. The TWQB certificate (No. 20290) which covers this operation permits this method of liquid waste disposal. No discharge is permitted from the site except when the rainfall exceeds a 25-year, 24-hour storm. Should runoff occur, it would flow into Willow Creek, thence into the Llano River, thence into the Colorado River.

Reichold Chemicals, Inc.

This chemical manufacturing plant is located at 2601 Reichold Blvd. in Austin, Texas, east of F.M. 1325, 1.3 miles north of the intersection of U.S. 183 and F.M. 1325.

The effluent from the plant is discharged into the City of Austin wastewater collection system tributary to the Walnut Creek sewage treatment plant. The TWQB permit (No. 01364) which covers the plant, allows a not-to-exceed volume of 15,000 gallons per day. The permit further states that effluent is to be treated to a quality acceptable to the City of Austin for discharge into its system. The pretreatment facilities consist of chemical treatment, sand filtration, an evaporation pond and a holding lagoon.

Roberts, John Inc. (Jewelry Manufacturing).

This operation is a jewelry manufacturing plant located on the west side of I.H. 35 approximately one mile south of the city limits of Austin, Texas.

Wastewater consist of treated domestic sewage from an extended aeration secondary treatment plant having a capacity of 10,000 gallons per day. The TWQB permit (No. 01258) which covers this facility allows a volume to be discharged not to exceed 11 gallons per minute, or an average of 10,000 gallons per day.

Effluent quality parameters are presented below:

EFFLUENT QUALITY PARAMETERS

Item	Monthly Average	(Not to Exceed) 24-Hour Daily Composite	Individual Sample
BOD	20	25	30
TSS	20	25	30

A chlorine residual of not less than 1.0 mg/l shall be maintained after a 20-minute detention time.

Effluent is discharged into an unnamed creek on company-controlled property, thence into Boggy Branch, thence into Onion Creek, thence into the Colorado River in Travis County, Texas.

Sanson and Sons Dairy.

This dairy operation with a capacity of 350 animals is located approximately one-half mile southwest of F.M. 969, approximately seven miles east-southeast of the intesection of F.M. 969 with F.M. 973 and approximately eight miles east of the City of Del Valle in Travis County, Texas.

Wastewater consists of runoff from dairy cattle feeding and holding pens (10 acres) and milking barn wash down. The TWQB permit (No. 01574) requires a no-discharge condition for the operation, except in the event of rainfall exceeding eight inches in any 24-hour period. However, if a discharge did occur, it would flow into the Colorado River. Wastewater from the dairy barn operation is routed by a collection ditch which flows to a sump fitted with a 300-gallon-per-minute pump. Twice daily the wastewater is transferred from the sump to approximately 150 acres of irrigable cropland.

Runoff waters from the 10-acre confinement pens are collected in a retention pond having a capacity of approximately 7.5 acre-feet. The pond is dewatered by irrigation of the same cropland mentioned above. Solid wastes are spread over the 150 acres of cropland at a rate of 10 tons per acre.

Scott, M.Q. (Swine Production).

This operation consists of a commercial swine-production facility having a 450-animal capacity. It is located south of a county road five miles northeast of the intersection of S.H. 71 and U.S. 281 and three miles southeast of the city limits of Marble Falls in Burnet County, Texas.

Wastewater consists of runoff from swine farrowing and finishing operations. The runoff is diverted to an earthen retention pond having a three acre-foot capacity. The pond is dewatered by evaportion and irrigation of 15 acres of pastureland. A trailer mounted 1,100 gallon tank is used to spread the liquid waste onto the pastureland. The TWQB certificate (No. 20028) covering the operation requires a no-discharge condition except in the event of a rainfall exceeding 7.7 inches in any 24-hour period. Should any discharge occur, it would be into an unnamed creek which flows into Doublehorn Creek, thence into the Colorado River.

Simpson and Simpson Hog Company.

This operation is a commercial swine production facility having a capacity of 1,075 animals. It is located east of S.H. 16 approximately five miles north of the intersection of S.H. 29 and F.M. 2241 and approximately 4-1/2 miles north of the city limits of Llano in Llano County, Texas.

Wastewater consists of runoff from eight acres of feeding pen area which drains across 20 acres of pastureland. Runoff is diffused by three terraces on the pastureland. The TWQB certificate (No. 20297) for this operation allows the wastewater to be disposed of by natural flow over the 20 acres of pastureland. Any runoff which occurs will flow into Wrights Creek, thence into the Llano River, thence into the Colorado River.

Smith, Elmer R. (Swine Production).

This commerical swine-production operation has a capacity of 695 animals. It is located adjacent to F.M. 2323 approximately 0.7 miles south of F.M. 152 and eight miles west of S.H. 16 and approximately 13 miles southwest of the city limits of Llano in Llano County, Texas.

The facilities include an enclosed nursery with slatted floors and an underfloor lagoon. Nursery wastes drain into two retention ponds with a total capacity of 0.4 acre-foot. Six retention ponds with an estimated total capacity of 15 acre-feet serve 31 acres of pens. The average flow from the nursery will total approximately 70 gallons per day. Swine confined on the 31 acres of pens will not be concentrated at greater than one animal per 2,000 square feet. Liquid waste is disposed of by evaporation, and solid waste is spread on farmland. The TWQB certificate (No. 20291) covering this operation permits the methods of liquid and solid waste disposal described above. Any discharge from the operation would flow into an unnamed tributary of Bullhead Creek which flows into Hickory Creek, thence into the Llano River, thence into the Colorado River.

Southwest Materials, Inc. (Sand and Gravel).

This sand and gravel washing operation is located three miles north of Garfield, Travis County, Texas on the Colorado River. The volume of washwater used averages 480,000 gallons per day with a maximum flow of 800 gallons per minute. Wastewater from the washing operation enters a settling pit which discharges into the Colorado River. The TWQB certificate (No. 20247) covers this sand and gravel washing operation.

Southwestern Graphite Company.

This operation consists of graphite mining and extraction. It is located approximately 2.1 miles north of the S.H. 29 crossover at Clear Creek in Burnet County, Texas.

Wastewater consists of process waste, mine drainage, and surface runoff. The TWQB permit (No. 00350) which covers the facilities allows an average volume of 300,000 gallons per day, not to exceed 480,000 gallons per day, and not to exceed 330 gallons per minute. Treatment of the wastewater consists of a tailings pond with a plastic lining to prevent seepage, a series of ditches and collection basins to collect runoff from the tailings ponds, neutralization of all waters, and a settling pond. Effluent is discharged into Clear Creek, thence into Inks Lake in Burnet County, Texas. Effluent is discharged into Clear Creek, thence into Inks Lake in Burnet County, Texas.

Effluent quality parameters as given in the discharge permit are shown in the table on the following page.

Texas Department of Mental Health and Mental Retardation (Austin State Hospital).

This institution is located at 4110 Guadalupe Street in Austin, Texas. Wastewater consists of boiler blowdown water containing no domestic sewage which is discharged into a city storm sewer. The TWQB permit (No. 10762) which is issued to this institution allows a not-to-exceed discharge volume of 1,500 gallons per day. Effluent is discharged into a city storm sewer adjacent to the hospital site, thence into Waller Creek, thence into the Colorado River (Town Lake). Effluent quality requirements are as follows.

Item	Average Content	Maximum Content
pH	8.0	8.5
Chlorides, ppm	201	400
Sulphates, ppm	124	248
Phosphates, ppm	28	56
Chromates, ppm	0.2	0.4
Total Dissolved Solids, ppm	835	1,670
Total Suspended Solids, ppm	97	200

Texas Rendering Company, Inc. (Meat Processing).

This meat processing operation is located north of F.M. 2336, approximately 0.8 mile east of the intersection of F.M. 2336 with S.H. 95, and 5.5 miles north of the City of Bastrop in Bastrop County, Texas. Wastewater consists of process water from the rendering plant and runoff from a holding pen. TWQB permit (No. 20329) which covers the operation requires a no-discharge condition.

All process wastewater is routed through a grease trap to a nine acre-foot holding pond which also collects drainage from 12.2 acres adjacent to the plant site. The wastewater is disposed of by irrigation of approximately 30 acres of pastureland. The discharge to the treatment facilities is not to exceed an average flow of 40,500 gallons per day, nor a maximum flow of 60,000 gallons per day, or 62.5 gallons per minute, as per the permit requirements. Any runoff from the irrigation opertion will flow into an unnamed creek which flows into Harris Creek, thence into Big Sandy Creek, thence into the Colorado River.

Voss, Ralph (Swine Production).

This operation consists of a commercial swine-production facility having a capacity of 1,500 animals. It is located 1-1/2 miles west of the intersection of S.H. 71 with F.M. 609 and approximately 2-1/2 miles west of the city limits of La Grange in Fayette County, Texas.

SOUTHWESTERN GRAPHITE COMPANY
EFFLUENT QUALITY PARAMETERS
(not to exceed)

Item	Monthly Average	24 Hour Daily Composite	Individual Sample
pH	6.8 - 7.5	6.8 - 7.5	6.5 - 8.5
Total Residue, mg/l	1380	1600	1850
Chlorine, mg/l	90	95	100
Sulphate, mg/l	700	750	800
Total Suspended Solids, mg/l	10	20	30
Volatile Suspended Solids, mg/l	5	10	15
Settleable Matter, mg/l	5	10	15
Immediate Oxygen Demand, mg/l	0.5	0.7	1.0
Biochemical Oxygen Demand, mg/l	10	15	25
Chemical Oxygen Demand, mg/l	15	20	30
Oil and Grease, mg/l	1	3	5
Free and Floating Oil	None	None	None
Color, APHA Units	50	110	150
Temperature, °F	85	90	95
Debris	None	None	None
Iron (Fe), ppm	1	2	5
Manganese (Mn), ppm	0.2	0.5	1.0

Toxic Compounds – None in such amounts that will cause the receiving water to be toxic to human, animal or aquatic life.

Foaming or Frothing Material – None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

Wastewater consists of washwater from nurseries, a finishing house, and farrowing house totaling approximately 3,000 gallons per day. Treatment facilities consist of four underfloor lagoons having a capacity of 5,000 cubic feet, two earthen lagoons having a capacity of 13,000 cubic feet, and an earthen retention pond having a capacity of 11 acre-feet. Liquid wastewater is disposed of by irrigation of 75 acres of pastureland. Solid wastes are disposed of on this same 75 acres. The TWQB certificate (No. 20476) for this operation requires a no-discharge condition except in the event of a 25-year, 24-hour rainfall.

Weirich Bros., Inc. (Sand and Gravel).

This operation consists of two portable sand and gravel washing plants located on the east side of Miller Creek seven miles east of Johnson City in Blanco County, Texas.

The TWQB permit (No. 00460) covering this operation allows a volume of from 300 to 450 gallons per minute to be discharged; however, the company has reported no discharge for the current period of record. Any discharge from the plant would result from seepage from a settling pond which would enter Miller Creek which flows into the Pedernales River, thence into the Colorado River.

Windy Hill Farm (Swine Production).

This operation consists of a commercial swine-production facility having a capacity of 1,260 animals. It is located aproximately 1/4 mile west of a county road approximately 2-1/2 miles northeast of the intersection of F.M. 165 with U.S. 290, and approximately six miles northwest of Dripping Springs in Hays County, Texas.

Wastewater consists of runoff from swine farrowing and finishing operations. Wastewater treatment facilities include slatted floors, underfloor lagoons, and diversion terraces and waterways to divert offsite runoff and collect waste and contaminated runoff in a retention pond having a capacity of 4.05 acre-feet. Wastewater is disposed of by irrigation of 50 acres of pastureland. Solid wastes are spread on 200 acres of pastureland.

The TWQB certificate (No. 20351) for this operation requires no discharge except in the event of a 25-year, 24-hour rainfall. If discharge were to occur, it would be into an unnamed creek which flows into Barton Creek, thence into the Colorado River (Town Lake).

Wootan, M.J. Custom Feeding Lot (Swine Production).

This operation consists of a commercial swine production facility having a capacity of 1,515 animals. It is located north of U.S. 71 approximately two miles east of the intersection of U.S. 71 and F.M. 2323 and approximately 1-1/2 miles southeast of the city limits of Llano in Llano County, Texas.

Wastewater consists of wash down of swine-production facilities. Treatment facilities include a system of terraces and waterways to divert offsite runoff and collect all wastes and contaminated runoff in a retention pond having a capacity of 6.13 acre-feet. The TWQB certificate (No. 20104) covering this operation requires a no-discharge condition except in the event of a 25-year, 24-hour rainfall. Liquid wastes are disposed of by evaporation and irrigation of 10 acres of pastureland. Solid wastes are also disposed of on the 10 acres.

Waste Load Allocation Discussion

The Texas Water Quality Act sets the policy of the TWQB to maintain purity of the waters of the State consistent with public health and enjoyment, the propagation and protection of fish and wildlife, the operation of industries, and the economic development of the State. In order to fulfill this policy, the TWQB sets water quality requirements for the interstate and intrastate surface waters of Texas. The first water quality requirements were published in 1967 as a starting point. A continuing program to update and improve these requirements is in effect by the TWQB, based on stream quality samples, effluent sampling data, mathematical modeling, and good judgment.

The major streams and rivers of the State were divided into segments, and the water quality of these segments was reviewed in light of proposed standards for each segment. Evaluation of each segment resulted in its classification as being either effluent limiting or water quality limiting. The distinction between the two classifications are briefly presented below.

Effluent Limiting.

Classification in this category may be as a result of: (1) water quality is in compliance with existing standards for a respective segment and will continue to be so with a "secondary" level of treatment for municipalities and best practicable control technology for industries under specified waste loads and volumes; or (2) although current water quality in a stream is in violation of standards, application of secondary treatment for municipalities and best practicable control technology for industries will result in compliance of standards under specified waste loads and volumes.

Water Quality Limiting.

Classification in this category may be as a result of: (1) the water quality of a segment is currently in violation of one or more of the proposed standards and will continue to be so even with application of secondary treatment for municipalities and best practicable control technology for industies; or (2) there is insufficient instream water quality data to verify either compliance with or violation of the standards.

Segmentation.

There are a number of water quality parameters which should be considered in determining compliance with standards. However, due to the need to develop an initial classification system, only three key parameters were used: pH, total dissolved solids, and dissolved oxygen. A more detailed discussion of water quality standards is presented in the Basin Plan, Volume 1.

The portion of the Colorado River within the CAPCO region has been divided into seven stream segments by the TWQB for the purpose of assessing compliance with water quality requirements. These segments are discussed below, beginning at the lower end of the CAPCO region and continuing upstream.

Segment 1402.

This segment consists of the portion of the Colorado River from the tidal portion (approximately river mile 23) up to and including Town Lake. Due to the occurrence of two pH violations below Austin, this segment has been designated as a water quality limiting segment. Waste load allocations are currently not being made with respect to pH. Rather, it appears the TWQB will require that the pH of any discharge within this reach comply with the stream standards, 6.5 to 8.5. A preliminary mathematical modeling of this segment with respect to BOD loading and its effect on dissolved oxygen concentrations (assuming permitted levels of discharges and effluent quality, and a seven-day, 10-year low flow in the Colorado River) indicated that no violation of standards would occur until about 1988. The State has since, however, adopted a seven-day, two-year low flow as the basis for modeling, which is somewhat higher than that used for this study.

On the basis of the above discussion, PL 92-500 would constitute the limiting conditions for this segment. Briefly, this would require secondary treatment by 1977 and "best practicable" treatment by 1983. Therefore, no waste load allocation is required for segment 1402 in this report.

Segment 1403.

This segment refers to Lake Austin which extends from Tom Miller Dam to Mansfield Dam, and is the first segment in the Highland Lakes chain, which includes segments 1403, 1404, 1405, 1406, 1407, and 1408. With exception of segment 1405 which covers Lake Marble Falls, the Highland Lakes are designated as water quality limiting segments due to the lack of adequate data. The Highland Lakes are presently under study with respect to obtaining these data, but this information was not available at the time this report was prepared. All recent TWQB permits for the segment require a no-discharge condition due to the above mentioned lack of data, because the lakes are a source of municipal drinking water, and because they are used for an extensive amount of direct contact water recreations.

After consulting with officials of the TWQB, it was decided that for the Highland Lakes, conventional secondary treatment followed by tertiary treatment in the form of total filtration of the effluent would be acceptable for the areas proposed for sewerage systems that did not have suitable land disposal sites. It must be noted that upon completion of adequate sampling and evaluation programs, the degree of treatment required for the Highland Lakes will probably change. As an example, nutrient removal may also be required in addition to filtration. In either case, this level of treatment is assumed to satisfy the minimum requirements of PL 92-500 for the 1983 objectives. Based on the above discussion, no waste load allocations are required for the water quality limiting segments of the Highland Lakes.

Segments 1404, 1406, 1407, 1408.

These segments represent Lakes Travis, Lyndon B. Johnson, Inks, and Buchanan respectively. The discussion for segment 1403 applies to these segments and will not be repeated for each segment separately.

Segment 1405.

This segment covers Lake Marble Falls, which extends from Alvin Wirtz Dam to Max Starke Dam. It has been designated as an effluent limiting segment since no violations of stream standards have been recorded. However, since Lake Marble Falls is one of the Highland Lakes, the conditions specified for Segment 1403 also apply here. Similarly, no waste load allocation is required at this time.

Existing Waste Loads.

Within each area plan the projected waste loadings as furnished by the TWQB are presented. Those projections, based on Census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in the Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream. The results of this analysis are shown in Table CA-8.

Very little of the available sampling data was consistent or reasonable; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in many of the loadings and estimates.

TABLE CA-8

CAPITAL AREA PLANNING COUNCIL

EXISTING WASTE LOADS

City or Community	Estimated Population Served	Discharge	Estimated Influent Loading Flow mgd	Estimated Influent Loading BOD lb./day	Estimated Influent Loading TSS lb./day	Estimated Treatment Reduction	Estimated Effluent Loading BOD lb./day	Estimated Effluent Loading TSS lb./day
Point Venture	400	No	0.04	91	107	80% / 80%	18	21
Lakeway Area	732	No	0.07	143	169	80% / 80%	29	34
Lago Vista	175	No	0.01	15	18	85% / 85%	3	3
Whitecliff Corporation	50	Yes	0.01	9	10	80% / 80%	2	2
Pedernales Country Club	53	No	0.01	9	11	85% / 85%	1	2
Marble Falls	2,200	Yes	0.22	433	509	80% / 80%	87	102
Horseshoe Bay	1,500	No	0.13	255	300	85% / 85%	38	45
Bastrop	3,200	Yes	0.31	400	359	85% / 81%	60	68
Elgin	3,500	Yes	0.38	522	364	54% / 0%	240	370
Smithville	3,500	Yes	0.30	475	280	74% / 58%	125	118
Johnson City	700	Yes	0.08	80	87	72% / 40%	22	52
Burnet	2,500	No	0.29	484	460	85% / 85%	73	69
Ellinger	200	Yes	0.02	32	11	80% / 80%	6	2
Fayetteville	400	Yes	0.04	53	40	95% / 83%	3	7
LaGrange	3,600	Yes	0.31	388	233	73% / 62%	103	88
Buda	500	No	0.05	63	83	72% / 36%	18	53
Giddings	1,400	Yes	0.21	184	166	57% / 42%	79	96
St. School for Boys	440	Yes	0.04	75	88	85% / 85%	11	13
Llano	2,600	Yes	0.26	228	323	43% / 43%	130	184
Manor	500	Yes	0.09	119	106	49% / 28%	61	77

PART II

METROPOLITAN PLAN
FOR
AUSTIN, TEXAS

Introduction.

The main objectives of this portion of the report are to (1) present one preliminary conceptual wastewater treatment design for the Austin metropolitan area to meet the requirements of PL 92-500 by the most cost-effective means, and (2) present nine preliminary conceptual designs for the Austin metropolitan area to meet the highest level of treatment objective. The designs presented for highest level of treatment consider biological treatment, physical-chemical treatment, and three land disposal methods of treatment.

The Austin metropolitan area in this report is defined as the entire area within Travis County. Austin is not the only city affected by this study area designation, as there are a number of surrounding towns and communities in the Austin vicinity, several of which are adjacent to the city limits. Thus, a number of non-metropolitan communities will influence and be influenced by any plans proposed for the City of Austin.

Metropolitan Area Characteristics.

Topography, Soils.

Travis County is located in what is known as Central Texas and contains approximately 1,015 square miles of surface area. The eastern portion of the county is rolling prairie, while the western portion begins what is known as the "hill country." The County is dissected from northwest to southeast by the Colorado River, which is the main drainage element for the County. The main creeks draining most of the County and tributary to the Colorado River are Barton, Williamson, Onion, Big Walnut, and Gilleland Creeks.

The soils in the County vary from non-existent in the hill country area, where there are large outcrops of limestone rock, to thin soils underlain by bedrock in the eastern and southern portions of the County. The majority of the soils in the County are silty clay and clay with a small band of sandy loam occurring along the Colorado River on nearly-level old stream terraces.

Geology.

Two fundamental geological elements of Austin are the Colorado River with its valley and the Balcones fault system. When the first of the great ice masses moved south over North America, about one million years ago, the climate changed and the Colorado River responded to high volumes of water entering its watershed, began vigorous erosion of the land cutting down through the rocks, and left a record of its higher courses in a series

terraces. At Austin, the valley of the Colorado River is about six miles wide and includes a number of terraces. The highest of the terraces in the northern part of the City is named the Asylum Terrace for the State Hospital which is built there. The municipal airport is also built on the flat stable surface of this terrace, which is about 200 feet above the level of the river. The next lower prominent terrace is the Capital Terrace about 120 feet above the river. Below the Capital Terrace, 60 feet above the river, is the Sixth Street Terrace. It is best preserved as a broad surface southeast of town around Montopolis. The next prominent lower terrace is the First Street Terrace. Most of the downtown area below Sixth Street is built on this terrace. Eastward, this terrace widens to about 3.5 miles. The lowest significant terrace is the River View Terrace, which is 20 to 35 feet above the river. The Austin Municipal Auditorium is built on this terrace.

The alluvial deposits of these terraces consist of silt, sand, and gravel. The gravels in the Manor area northeast of Austin and the Creedmor area south of Austin contain crystalline rocks derived from the Llano region.

The other fundamental geologic element of Austin is the Balcones fault zone and escarpment. The landscape changes abruptly at Austin from rolling prairies east of the City to a line of wooded hills rising as much as 300 feet above the plain west of the Colorado River. Austin straddles the fault zone with the northwestern part of the City on the northwest side of the zone. The Colorado River follows the fault zone from Mount Bonnell to the Tom Miller Dam. The rocks of the hills are mostly limestone and cherty limestone about 100 million years old. They have a layered structure of hard limestone interbedded with softer marly clay. Many of the layers are fossiliferous containing fossils that were deposited when this part of Texas was a warm, shallow sea.

South and east of the fault system are younger rocks, 80 to 100 million years old, which include limestone, chalk, marl, and shale. The greater part of Austin is built on these rocks. The chalk, named Austin Chalk, is locally mantled by terrace gravels and supports the large structures of the City--the downtown area, the Capitol, and the University of Texas. The chalk forms a rolling hilly landscape with open grasslands. At the time the Austin Chalk was deposited, a volcano erupted within the fault zone. The eroded core of the volcano rises south of Austin to form Pilot Knob.

Social and Economic Description.

Population, Analysis.

In 1839, Mirabeau B. Lamar, President of the Republic of Texas, appointed a commission to locate a site for the permanent capital. The community of Waterloo was selected and renamed in honor of Stephen F. Austin. In 1845, Texas was annexed to the United States, and in 1850, Austin was selected as the State Capitol. The 1850 United States Census listed a population of 3,138 from Travis County, 629 of which constituted

the population of Austin. The first railroad came to Austin in 1871, and by 1880, the population had grown to 11,013 people. The University of Texas was opened in 1883, and in 1888, the present capitol building was dedicated.

In 1920, Austin's population was 34,876. In the 1920's, Austin adopted the council-manager form of city government, and the Austin-to-Houston highway opened. Natural gas and the first air mail arrived, a weather bureau station was established, and the City Council adopted a master plan for future development.

In 1940, the Census Bureau counted 87,930 people in the City and 111,053 people in Travis County. During the early 1940's, Bergstrom Air Force Base was established. Within the five years following World War II, almost 11,000 housing units were built, and by 1950 the population of Austin reached 132,459. A new master plan for the City was developed during the 1956-1958 period and adopted by the Council in 1961. The development of new State office buildings proceeded at a rapid pace and a three million dollar auditorium and convention center was opened in 1959.

In 1960, Town Lake was created by the completion of Longhorn Dam, and the City population was 186,545. During the 1960-1970 decade, the I.H. 35 and a number of other highway improvements were completed, the Internal Revenue Regional Service Center and the new Post Office and Federal Building opened, and the Veterans Administration constructed a regional computer center in Austin.

Private enterprise has built and is continuing to build many new office buildings, shopping centers, other commercial facilities, light industrial plants, and research facilities. The Glastron Boat Works and Trecor, Inc., are typical of this activity. Industrial development increased further with the location of the IBM manufacturing plant and Infotronics Corporation in 1967. Texas Instruments, Inc., expanded into manufacturing in 1969, and Westinghouse Electronic Corporation began construction of a gas turbine plant a few miles north of Austin. More recently, the initial construction of a Motorola facility has been accomplished.

Programs in urban renewal, community development, economic opportunity, and the Model Neighborhood Program have been actively implemented to improve housing, environmental and economic conditions in Austin. Austin and Travis County have experienced consistent increases in population since the 1850's. In Austin, development has occurred in every direction from the original 640 acres. The main growth of the County and City has been the result of people moving into the area from outside Travis County. The historical population growth of Austin and Travis County from 1840 through the 1970 census is presented in the following table, with respective percent increases by decades from 1850.

POPULATION INCREASES

	Austin		Travis County	
Year	Number	Percent Increase	Number	Percent Increase
1840	856	-	-	-
1850	629	-26.5	3,138	-
1860	3,494	455.4	8,080	157.0
1870	4,428	26.7	13,153	62.8
1880	11,013	148.7	27,028	105.5
1890	14,575	32.3	36,322	34.4
1900	22,258	52.7	47,386	30.5
1910	29,860	34.2	55,620	17.4
1920	34,876	16.8	57,616	3.6
1930	53,120	52.3	77,777	34.9
1940	87,930	65.5	111,053	42.7
1950	132,459	50.6	160,980	45.0
1960	186,545	40.9	212,136	31.8
1970	251,808	35.0	295,431	39.3

The projected population figures for Austin and Travis County to be used for this study were prepared by the TWDB and are presented below:

POPULATION PROJECTIONS

	Austin		Travis County	
Year	Number	Percent Increase	Number	Percent Increase
1980	326,880	29.8	383,190	29.7
1990	429,920	31.5	498,670	30.1
2000	556,360	29.4	639,040	28.1
2010	714,950	28.5	812,710	27.2
2020	912,110	27.6	1,026,580	26.3

An analysis of the composition of the City's existing population indicates three segments: resident, university, and institutional. The following tabulation shows the changes in the population represented by these three segments from 1950 to 1970.[1]

1 "The Highland Lakes System Comprehensive Wastewater Study 1970-1990," Phase I, Freese, Nichols, and Endress, Inc., Consulting Engineers, July 1970.

POPULATION COMPOSITION

Year	Total	Resident	Univ. of Texas Total	Univ. of Texas Out-of-County	Institutional
1950	132,459	112,359	17,450	13,400	6,700
1960	186,545	163,475	20,460	15,570	7,500
1970	246,800[1]	212,800	34,000	24,500	9,800

The ethnic composition of the population of Austin and Travis County has changed measurably over the last 20 years. The following table indicates a constant decrease in the proportion of the Negro population to the total population and a slight decrease in the Anglo population. The greatest change has taken place in the Latin American segment. In Travis County, over 80 percent of the Negro population live in the eastern section of the County and City. The Latin American population is more scattered, but almost one-half live in East Austin, in Montopolis, and in small community and rural areas in the eastern part of the County.

POPULATION ETHNIC CHARACTERISTICS

	Anglo (%)		Negro (%)		Latin American (%)	
Year	Austin	Travis County	Austin	Travis County	Austin	Travis County
1950	77.6	76.4	13.4	14.1	9.0	9.5
1960	73.9	74.9	13.3	12.8	12.8	12.3
1970	73.5	74.4	11.9	11.5	14.6	14.1

Land Use Projections.

In order to fulfill the requirements of the Colorado River Wastewater Management Study, land-use projections through the year 2020 were compiled by the Corps of Engineers. At the time this study was prepared, the City of Austin did not have published land-use projections extending this far into the future. The anticipated land-use projections thus compiled for the years 1980, 1990, and 2020 are shown on Plate A-1.

In compiling the land-use exhibit, it was recognized that the dynamic growth projected for Austin would require frequent changes and/or updating of the land-use projections. It is not the intent of this wastewater management study that the anticipated land-use projections be accepted as a final document by anyone, or that growth patterns be construed to mean exact locations indicated on the exhibit, but that it is a generalized interim plan to meet the requirements of the study. The City of Austin is presently engaged in an updating project, and this plan should not be taken as a replacement since it preceeds the updating project.

1 U.S. Bureau of the Census, preliminary data for 1970.

Members of the staff of the City of Austin were consulted in preparing the land-use exhibit as to possible potential development areas and general directions in which development is predicted to occur. It should also be noted that, in the development of the plans, the fact that Austin does not have zoning laws was also taken into consideration when plotting growth patterns.

In preparing the present through 1980 portion of the exhibit, the "Basic Data about Austin and Travis County" publication by the City of Austin was used extensively. This time increment was chosen because there are a number of new subdivisions which have recently opened and which are proposed for the near future. Several of these may be of considerable size, in excess of 1,000 acres. Due to this great potential development within the near future, it was decided that this designation would be more appropriate with development trends.

The 1980 projected population figure, when distributed over the designated gross area of development for 1980, results in an average gross population density of less than five persons per acre. The present gross population density of the City is about 6.9 persons per acre, so the 1980 land-use projection should be somewhat conservative by present development characteristics.

In preparing the 1990 and 2020 projected land use, very general areas are also indicated rather than exact areas or tracts which could be identified. However, the trend of development into particular areas, as well as the extent of such development, can still be seen as part of the overall development trend for the City. Again, population projections were used to project gross development area in striving for a realistic land-use exhibit. The 2020 population projection figure, when distributed within the total "by 2020" projected area of development, results in a gross population density of approximately six persons per acre, which, although lower than the present gross density, is still a reasonable figure by present standards.

Three general land-use classifications are presented on the exhibit. Residential and light-commercial land use includes single and multi-family dwelling units as well as local commercial establishments such as service stations, grocery stores, and shopping centers. Public land use includes parks, greenbelts, cemeteries, airports, State and Federal offices and institutions. Heavy commercial and industrial land use includes warehouses and manufacturing areas which are generally areas specifically set aside for these purposes.

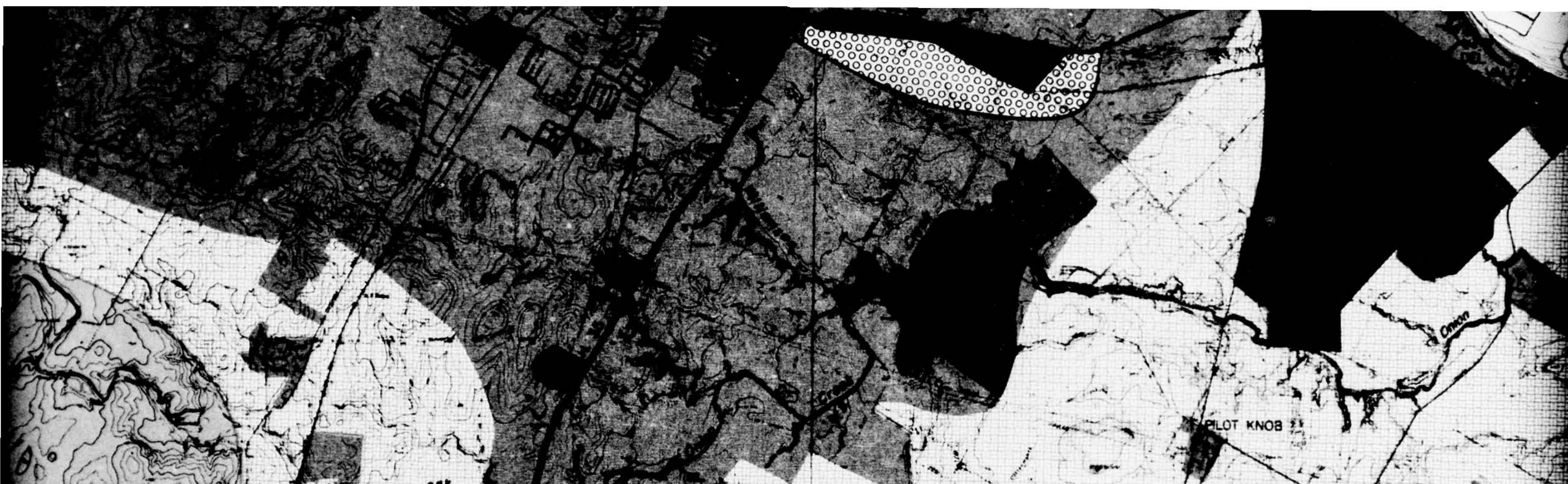
Water Resources.

Ground Water.

The major aquifer in the Austin area is the Trinity Sand that was in the past tapped by deep wells drilled by various public and private agencies. West of the Balcones fault zone, where arable lands are scarce, the

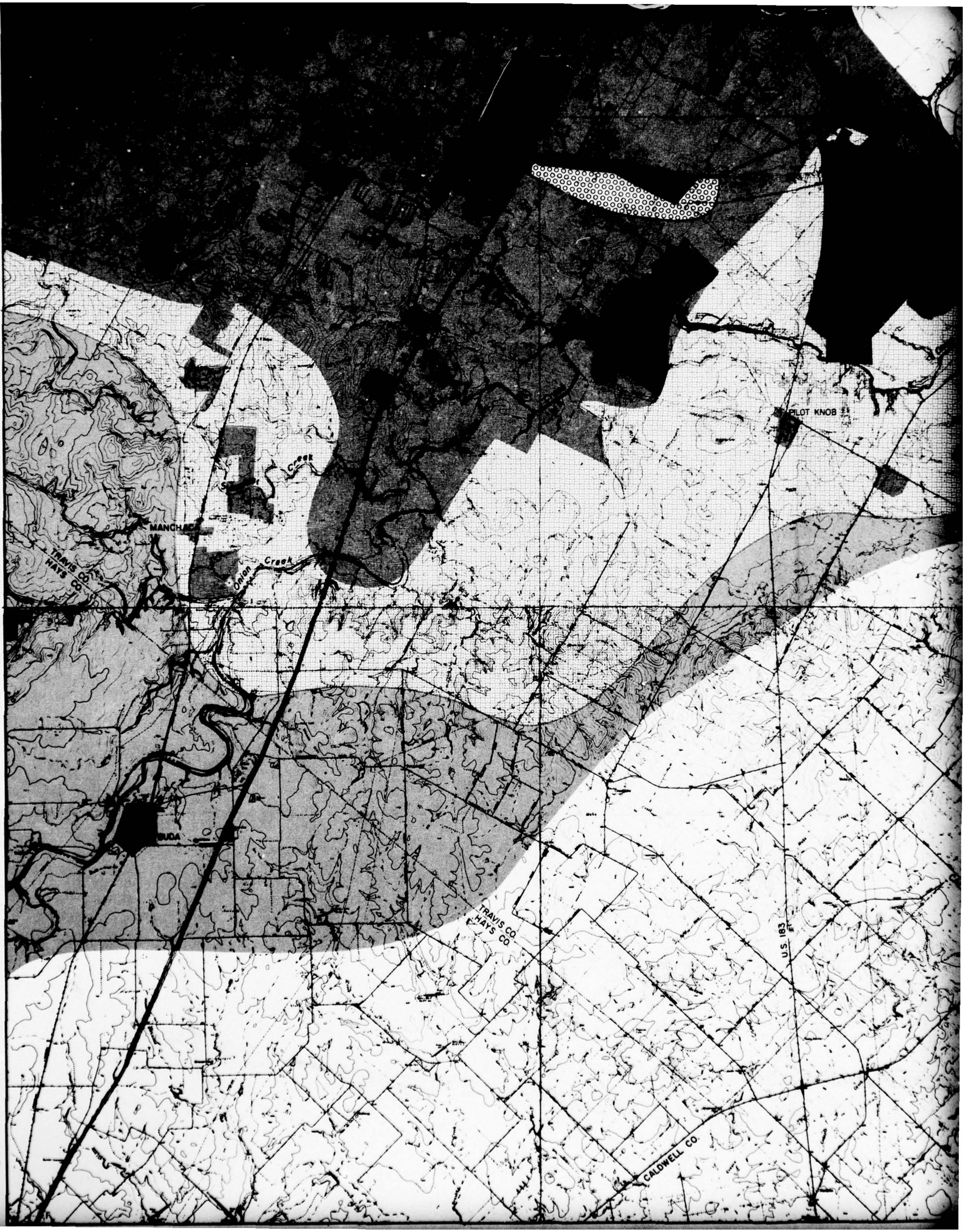

U.S. 183
OLLYVILLE
WILLIAMSON
TRAVIS CO.
Lake Austin

2


PILOT KNOB
Onion Creek
Creek
Onion
TRAVIS
HAYS

HORNSBY BEND
Colorado
River
GARFIELD
PILOT KNOB
TRAVIS CO.
BASTROP CO.
ELROY

4


PILOT KNOB
Creek
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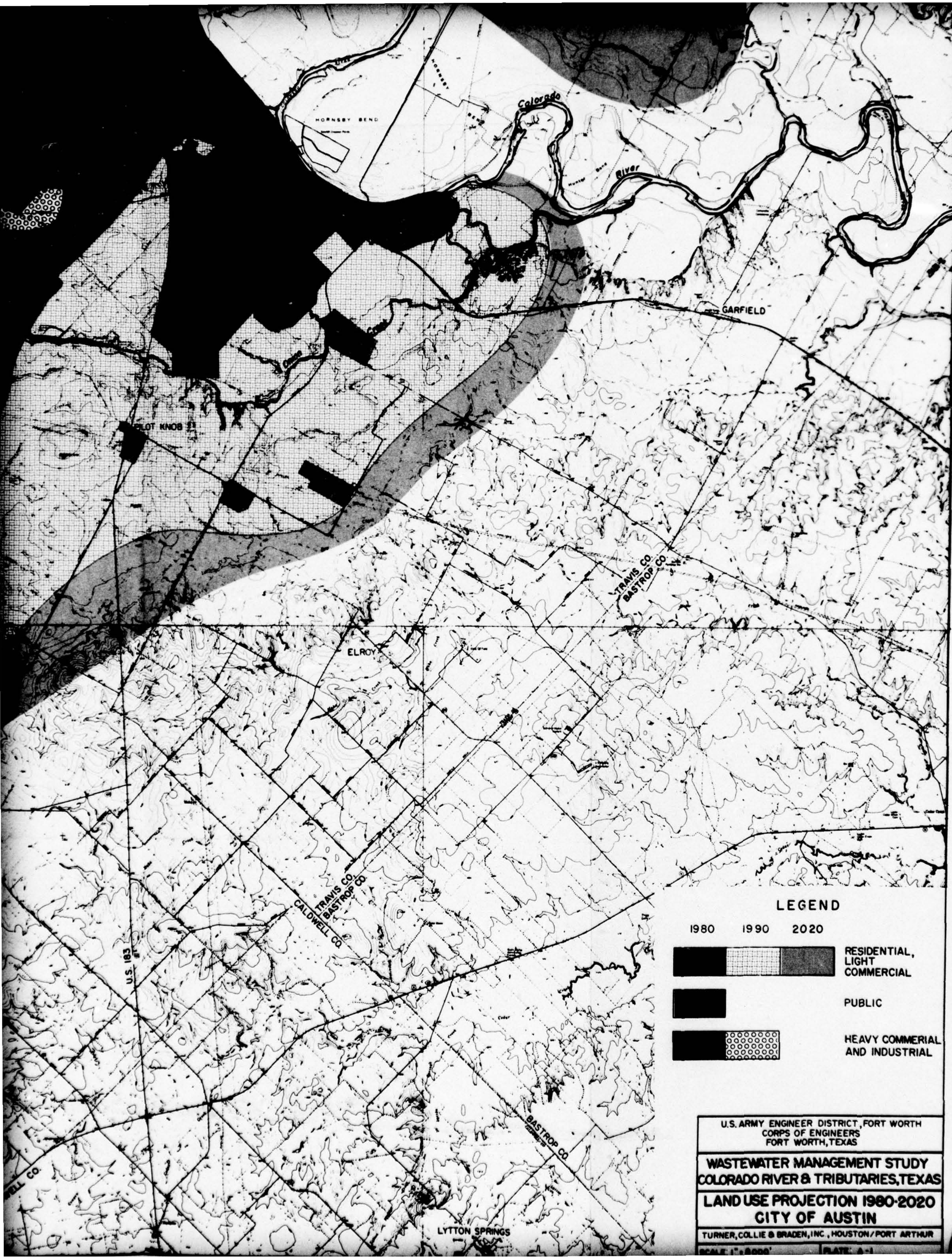
HAYS CO.
Onion Creek
BUDA
TRAVIS CO.
HAYS CO.
U.S. 183
CALDWELL CO.

5


HORNSBY BEND
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River
GARFIELD
PILOT KNOB
TRAVIS CO.
BASTROP CO.
ELROY
TRAVIS CO.
BASTROP CO.
CALDWELL CO.
U.S. 183
BASTROP CO.
LYTTON SPRINGS
LEGEND
1980
1990
2020
RESIDENTIAL, LIGHT COMMERCIAL
PUBLIC
HEAVY COMMERIAL AND INDUSTRIAL
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAND USE PROJECTION 1980-2020
CITY OF AUSTIN
TURNER, COLLIE & BRADEN, INC., HOUSTON/PORT ARTHUR

aquifer is closer to the surface, being some 800 to 1,000 feet deep. East of the fault zone, deep and expensive wells must pass through a succession of younger rocks to a depth of about 2,000 feet to reach the aquifer. Small amounts of water are also contained in the relatively porous terrace gravels. Wells in the lower terrace along the river provide good, strong flows for irrigation, the source being river water that saturates these formations in the valley.

Barton Creek, in the southwest part of the City, flows over an outcrop of the Edwards Formation. The Edwards is a very porous, permeable unit in the subsurface southwest of Austin and is the major aquifer supplying water to the City of San Antonio. This formation nourishes a strong spring at Zilker Park on the banks of Barton Creek known as Barton Springs.

Surface Water.

The City's major water resource is Lake Austin, which was formed by Tom Miller Dam. Lake Austin covers some 3,000 surface acres and is within the city limits. The 150-mile-long network of lakes created along the Colorado River, known as the Highland Lakes, have a combined storage capacity of approximately 3,300,000 acre-feet of water, 800,000 acre-feet of which is reserved for flood control. The estimated safe water yield of this source, which flows through Austin, is in excess of 600,000,000 gallons per day.

The City of Austin has three existing water treatment plants with a combined design capacity of 82,000,000 gallons per day. Each plant has a safe overload capacity of an additional 50 percent and a short time overload capacity of 100 percent. The average daily water consumption at present is in the neighborhood of 55,000,000 gallons per day. The projected water demands for the City of Austin, supplied by the TWDB, show a year 2020 total municipal and industrial use of approximately 200,000,000 gallons per day. This figure, when compared to the estimated safe yield above, shows that Austin has an abundance of water to meet its needs throughout the study period and beyond. A more detailed description of quantity of surface water available to Austin was presented in the Hydrology discussion for the CAPCO region.

Projected Water Use.

The projected water use for the years 1970-2020, as determined by the TWDB, is presented below. The per capita water use was determined by dividing the water use by the respective projected population.

Austin Water Use Projections (Acre-Feet)

	1970	1975	1980	1990	2020
Municipal Requirement	49,937	59,964	68,593	92,589	212,164
Industrial Requirement	3,048	3,621	3,850	4,350	6,267
Per Capita Use (Gals.)	177	185	187	192	208

Existing Wastewater Systems.

Existing Sewage Collection System.

The City of Austin's existing sewerage system consists of three separate systems, each having its own interceptors, and wastewater treatment plant. The three systems, designated as the Central System, the Williamson Creek System, and the Walnut Creek System are shown on Plate A-2.

A study was made for the City in 1969, entitled "Study of Wastewater Collection System, Phase I," by Horner and Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The entire sewage collection system north of the Colorado River was evaluated in determining the feasibility of the Crosstown Interceptor Tunnel. The recommended plan, as proposed in the report, generally consists of constructing the deep tunnel and, in addition, some minor supplementary relief sewers. The proposed relief sewers, which the City also included in its "Capital Improvements Program, 1972-1977," are presented under the Proposed Wastewater Systems section of this report.

The remainder of the collection system south of the river not covered in the above report was evaluated based on year 2020 development conditions. The proposed relief sewers and new interceptor sewer systems for this area are also presented in the Proposed Wastewater Systems section of this report.

There are very few septic tanks being used in the City, since the existing collection systems cover essentially the entire area within the city limits. All new subdivisions constructed within the city limits or in areas to be annexed by the City must construct sewer systems to meet City standards.

Existing Sewage Treatment Plants.

As mentioned above, Austin has three existing wastewater treatment plants; the Govalle plant, the Williamson Creek plant and the Walnut Creek plant. These facilities are shown on Plate A-2. In addition, the City also has an oxidation pond facility in Hornsby Bend which stabilizes excess sludge produced at the Govalle plant and treats sewage from the Bergstrom Air Force Base - Del Valley Area. The four wastewater treatment facilities are described below, based on the discussion in the Highland Lakes Report and on-site inspections performed for this report. A more detailed discussion of the facilities, including flow diagrams of the plants, is included in Appendix A at the conclusion of the Austin discussion.

The Govalle Wastewater Treatment Plant.

The Govalle plant is located southeast of the intersection of Bolm Road and Ed Bluestein Blvd. The existing plant has a rated capacity of 40 mgd. It is a contact-stabilization type plant and consists of mechanically-cleaned bar screens, aerated grit chambers, skimming tanks or high rate primary clarifiers, flow meters, aeration basins, final clarifiers, blowers, sludge pumps, chlorine feed machines, chlorine contact chamber, sludge aeration tanks, and all necessary auxiliary equipment.

JOLLYVILLE
U.S. 183
WILLIAMSON CO.
TRAVIS CO.
LINE A-2-b
I.H. 35
LINE AA-1-f-1
LINE AA-1-d
LINE AA-1-h
BULL
CREEK
BIG
WALNUT
DRY
CREEK
SHOAL
CREEK
WALNUT
CREEK
CREEK
WEST
LAKE
Lake Austin
TAYLOR
SLOUGH
WALLER
CREEK
FORT
VIEW
BRANCH
BRANCH
C.I.T.
WEST LAKE HILLS
JOHNSON
CREEK
HILLS
ROLLINGWOOD

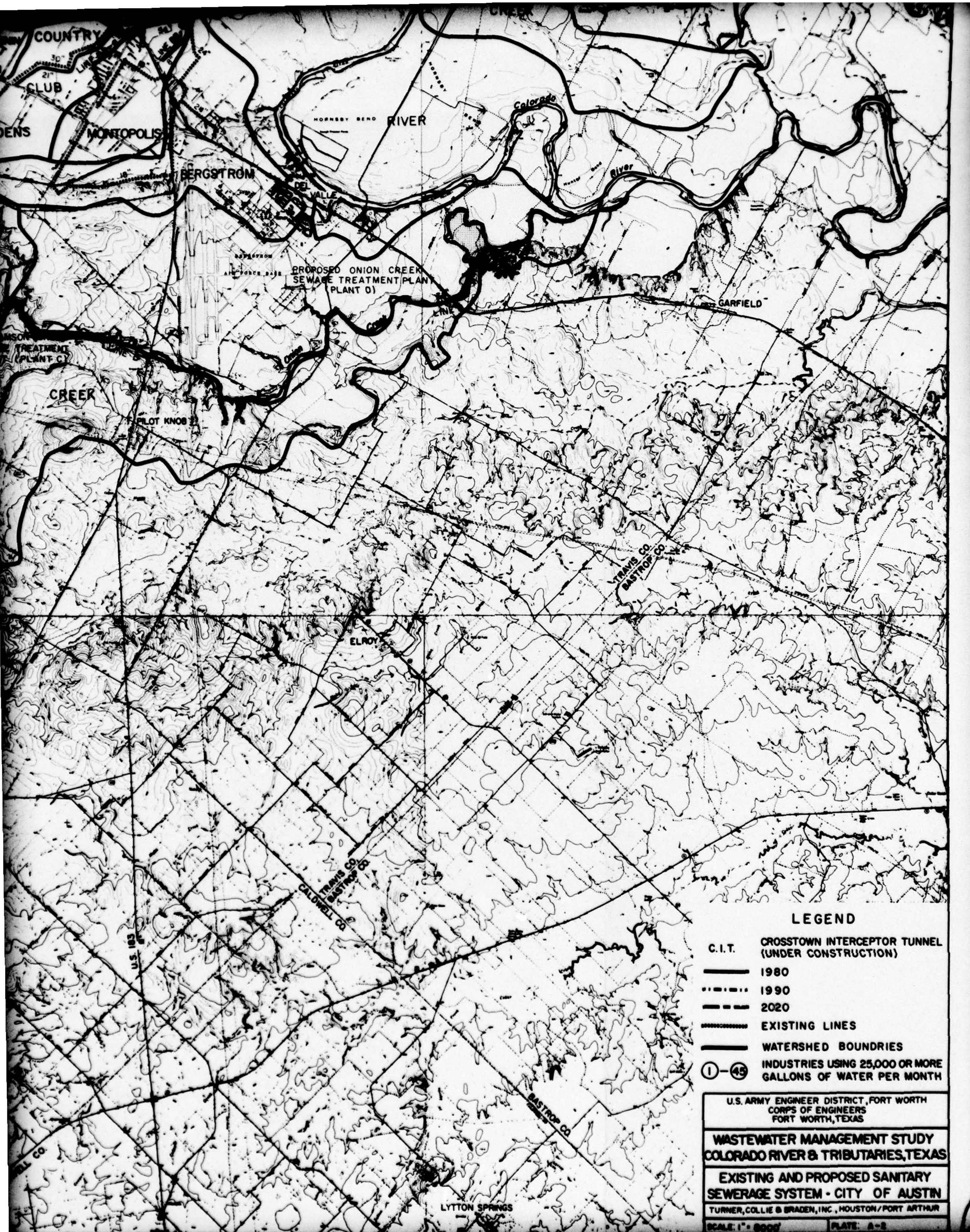
2


PFLUGERVILLE
LINE A-2-D
I.H. 35
BIG
WALNUT
CREEK
MANOR
BECKER
LINE A-1-G
LINE A-1-H
12" FM
Decker Creek Reservoir
BRANCH
FORT
LINE A-1

DRY CREEK
SHOAL CREEK
WALNUT
WEST LAKE
TAYLOR SLOUGH
WALLER CREEK
CREEK
BRANCH
WEST LAKE HILLS
JOHNSON CREEK
HILLS
DELLANA CREEK
ROLLINGWOOD
BARTON CREEK
WALNUT CREEK SEWAGE TREATMENT PLANT (PLANT A)
LINE BB-3
GOVALLE SEWAGE TREATMENT PLANT (PLANT B)
BOULDIN CREEK
TINNIN BRANCH
COUNTRY CLUB GARDENS
MONTOPOLIS
OAK HILL
LINE CC
WILLIAMSON
BERGSTROM
DEL VALLE
HORNSBY
CREEK
WILLIAMSON CREEK SEWAGE TREATMENT PLANT (PLANT C)
CREEK
PILOT KNOB
I.H. 35
LINE C-2
ONION
MANCHACA
TRAVIS CO.
HAYS CO.

MANOR
BECKER
WALNUT CREEK SEWAGE TREATMENT PLANT (PLANT A)
GOVALLE SEWAGE TREATMENT PLANT (PLANT B)
LINE BB-3
COUNTRY
CLUB
GARDENS
MONTOPOLIS
BERGSTROM
DEL VALLE
HORNSBY BEND
RIVER
Colorado
River
ELM
CREEK
PROPOSED ONION CREEK SEWAGE TREATMENT PLANT (PLANT D)
WILLIAMSON SEWAGE TREATMENT PLANT (PLANT C)
PILOT KNOB
GARFIELD
Decker Creek Reservoir
LINE A-1a
12" FM
TRAVIS CO.
BASTROP CO.


BOULDIN
TINNIN
COUNTRY
CLUB
OAK HILL
CREEK
BRANCH
Williamson
Creek
LINE CC
GARDENS
MONTOPOLIS
BERGSTROM
DEL VALLE
WILLIAMSON
CREEK
PROPOSED
SEWAGE TR
WILLIAMSON
SEWAGE TREATMENT
PLANT (PLANT C)
CREEK
PILOT KNOB
I.H. 35
LINE C-2
Slaughter
Creek
ONION
MANCHACA
Onion
Creek
TRAVIS CO.
HAYS CO.
BUDA
U.S. 183
CALDWELL CO.


COUNTRY
CLUB
MONTOPOLIS
BERGSTROM
DEL VALLE
HORNSBY BEND
RIVER
Colorado
River
PROPOSED ONION CREEK
SEWAGE TREATMENT PLANT
(PLANT D)
TREATMENT
(PLANT C)
CREEK
PILOT KNOB
GARFIELD
TRAVIS CO.
BASTROP CO.
ELROY
CALDWELL CO.
U.S. 183
LYTTON SPRINGS
LEGEND
C.I.T.
CROSSTOWN INTERCEPTOR TUNNEL (UNDER CONSTRUCTION)
1980
1990
2020
EXISTING LINES
WATERSHED BOUNDRIES
1 — 45
INDUSTRIES USING 25,000 OR MORE GALLONS OF WATER PER MONTH
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
EXISTING AND PROPOSED SANITARY
SEWERAGE SYSTEM - CITY OF AUSTIN
TURNER, COLLIE & BRADEN, INC., HOUSTON/PORT ARTHUR
SCALE: 1" = 2000'
PLATE: A-2

A 10 mgd addition to the plant has facilities to screen, settle, and chlorinate storm flows between 60 and 125 mgd. The plant effluent is discharged into the Colorado River. The sludge is aerated in sludge aeration tanks and is then pumped to the Hornsby Bend oxidation ponds.

The present TWQB discharge permit for the Govalle plant allows an average of 40 mgd, a maximum not-to-exceed flow of 125 mgd, and a maximum not-to-exceed flow of 86,805 gallons per minute. The present average flow treated at the plant is approximately 26 mgd. The plant serves an estimated population of approximately 140,000[1] as well as most of the City's larger industries.

The Williamson Creek Wastewater Treatment Plant.

The Williamson Creek plant is located south of the City at the confluence of Onion and Williamson Creeks. The existing plant consists of a lift station, screen, comminutor, flow meter, and two treatment units. One of the two treatment units consists of two aeration tanks with mechanical aerators and three oxidation ponds. The rated capacity of the plant is 3 mgd. Plant effluent can be discharged into either Williamson Creek or Onion Creek.

Present flows average approximately 1.3 mgd. The TWQB discharge permit allows a not-to-exceed average of 2.2 mgd; however, due to evaporation from the large oxidation ponds, no discharge has occurred since the plant was placed in operation.

The Walnut Creek Wastewater Treatment Plant.

The Walnut Creek plant is located east of Austin on F.M. 969 on the east side of Walnut Creek. The existing plant consists of a flow meter, comminutor, hand raked screen, two aeration tanks with mechanical aerators, and two 40-acre oxidation ponds. The rated capacity of the plant is 2.5 mgd, which is the TWQB permitted average flow.

The Hornsby Bend Oxidation Ponds.

The Hornsby Bend oxidation pond facility is located adjacent to the Colorado River in what is known as the Hornsby Bend of the river, approximately 13,000 feet southeast of the Govalle Wastewater Treament Plant. The existing facility consists of a mixing chamber, three oxidation ponds with a combined surface area of approximately 191 acres, and an aeration tank for pretreating raw sewage from the Bergstrom Air Force Base - Del Valley area. Excess activated sludge pumped to the facility from the Govalle plant is diluted before dispersion into the ponds by either mixing it with river water or recirculating stabilized pond water. Normally, the

1 "Report on Wastewater Treatment Walnut Creek Site for Austin, Texas," Black and Veatch, Consulting Engineers, Dallas, Texas, and S.A. Garza Engineers, Inc., Austin, Texas, 1971.

effluent is discharged into the Colorado River; however, there is no discharge when pond water is recirculated for dilution of the sludge.

Although the pond system has no flow measuring device, the volume of excess sludge pumped to the facility is measured at the Govalle plant. The volume of river water used for dilution is estimated from the capacities of the river water pumps. The TWQB discharge permit allows an average discharge of 6.0 mgd, a maximum not-to-exceed flow of 12.0 mgd, and a maximum not-to-exceed flow of 8,300 gallons per minute.

Existing Water Treatment Plants.[1]

The City of Austin owns and operates three water treatment plants with a present combined design capacity of 82 million gallons per day. All three plants lime-soften raw water, and lime sludge, composed primarily of calcium carbonate, is the chief waste produced. Approximately one ton of the sludge on a dry weight basis is produced for each million gallons of water treated. Filter backwash water is also produced which contains considerable amounts of suspended solids. A description of the improvements in the methods for disposal of the sludge and filter backwash, as previously described in the Highland Lakes Report, is presented for each plant as follows.

The Thomas C. Green Plant.

The Thomas C. Green Plant is located at 600 West First Street in Austin and has its intake on Town Lake. The sludge now produced is pumped to centrifuges for dewatering, and the concentrated sludge is hauled to the Walnut Creek Wastewater Treatment Plant site for final disposal. Supernatant from the centrifuges is discharged into a sanitary sewer in Second Street. The filter backwash water is discharged to a holding tank and is recyclyed to the plant. No filter backwash water is discharged from the plant.

Grab samples of supernatant from the sludge settling tanks collected on August 17 and 18, 1970, showed a Total Suspended Solids concentration of 10 mg/l and a Turbidity of 25 units (JTU). The quality of this supernatant is much better than that required by the TWQB (150 mg/l solids average).

The Albert R. Davis Plant.

This plant is located at 3500 West 35th Street and has its intake on Lake Austin. The sludge produced is dewatered by means of two centrifuges and the concentrated sludge is hauled to the Walnut Creek

1 "The Highland Lakes System Comprehensive Wastewater Study, 1970-1990," Phase II, Freese, Nichols, and Endress, Consulting Engineers, December 1970.

Wastewater Treatment Plant site. The centrate from the centrifuge is discharged into the domestic sewer system. Filter backwash is presently discharged into Lake Austin, but a contract has been awarded to install a holding tank and pump to recycle this water back to the plant.

Tests made in the City's laboratory indicate that the calculated average suspended solids content of the filter backwash water is 21.8 mg/l, which is within the permitted value of 150 mg/l.

The Albert H. Ullrich Plant.

The Ullrich plant is located at 1000 Forest View Drive, which is on the west side of Lake Austin just below Tom Miller Dam. The intake for the plant, however, is above Tom Miller Dam on Lake Austin. The sludge is pumped to a centrifuge and the concentrated sludge is hauled to the Walnut Creek Wastewater Treatment Plant site. The centrate is discharged to a holding tank and recycled to the centrifuge or through the plant. The filter backwash water is stored in a holding tank and recycled to the plant process. No water or waste is discharged from the plant, hence no TWQB permit is required for the Ullrich plant.

Existing Sanitary Landfills.

The City of Austin at present operates two sanitary landfills: the Steiner Sanitary Landfill and the Smith Sanitary Landfill.

The Steiner Sanitary Landfill.

The Steiner landfill is located south of the City approximately 1/2 mile north of the intersection of F.M. 812 with F.M. 973. It covers approximately 36 acres with dimensions of approximately 2,000' x 800' x 10' deep. The landfill is located in a silty clay formation having a low porosity.

The refuse is spread, sprinkled with water, compacted, and covered with soil. An earthen dam prevents surface runoff from flowing into Onion Creek. No pollution hazard exists from this landfill operation.

The Smith Sanitary Landfill.

The Smith landfill is located northeast of Austin approximately 2,000 feet north of the Cameron Road bridge over Big Walnut Creek. The site is comprised of approximately 60 acres (2,600' x 1,000 x 30' deep) sloping toward Big Walnut Creek.

The refuse is spread, sprinkled with water, compacted, and covered with soil. There is no potential pollution hazard from this operation since it is constructed in clay and since surface runoff drains away from the operation.

Industrial Wastewaters in the Metropolitan Area.

An industrial waste control survey, dated February 1971, was made by Samuel D. Standridge, Industrial Waste Supervisor, for the City of Austin. The study indicated that there were 45 industries within the Austin metropolitan area which utilize 25,000 gallons or more of water per month. The industries, shown on Plate A-2, are categorized in Table A-1 according to type waste produced and/or product produced. The values given for BOD and Total Suspended Solids Concentrations are generalized averages obtained from the literature. The averages in reality may be higher or lower, depending on the effectiveness of waste control within each industry.

Table A-2 provides a listing of these industries, their mailing addresses, and the amount of water used during August and February 1969. The majority of these industries would not be considered as heavy production industries or industries which contribute a great deal to the wastewater loads. Several industries in the Austin area are not presently connected to the sanitary wastewater collection system due to their remoteness to the existing collection system. However, as City facilities are expanded, this condition will inevitably change.

In February 1970, the City Council of Austin passed and approved an ordinance prescribing and levying rates and charges for sales made and services rendered in connection with the water works system and the sanitary sewer system. The rate charge for industry is computed on water usage and/or sewer service. The Waste Ordinance sets limits on wastes discharged to sanitary sewers as well as watercourses. Charges on waste discharges exceeding normal BOD, COD, or SS concentrations are established therein.

The biological treatment process utilized at the Govalle Wastewater Treatment Plant has been upset on many occasions, and on more than one occasion fish kills were observed in the Colorado River below the Govalle plant. Some of the industries produce effluents that are capable of and have apparently caused treatment and other problems. A marked decrease in plant upsets has occurred since the passage of the Industrial Waste Ordinance.

Data collected over a five-year period from 1964 through 1969 were tabulated and summarized indicating maximum, minimum, and averages for water quality determinations on raw wastewater entering the three City of Austin wastewater treatment plants. From the results of this study, tabulated in Table A-3, it does not appear that Austin has a major problem with industrial wastes entering the wastewater collection system. Industrial development in the City has increased in the past and is expected to do so in the future, but the industries have not been of the type to cause a great deal of collection and treatment problems.

TABLE A-1

INDUSTRIAL WASTE CHARACTERISTICS

AUSTIN METROPOLITAN INDUSTRIES

Type of Industry	Number	BOD Averages ppm	Total Suspended Solids Averages ppm
Canners	1	2,000	1,500
Potato Chips	1	1,500	2,000
Food Processors	2	1,200	260
Poultry	2	2,500	1,000
Dairies	1	1,500	600
Candy	2	3,000	400
Bakeries	5	1,500 (estimated)	1,500 (estimated)
Laundries	8	1,000	1,500
Beverage Bottling	7	2,000 (estimated)	2,000 (estimated)
Metal Plating	4	Toxic waste usually low in BOD	–
Chemical and related Industries	12	Wide range, depending on products produced	–

TABLE A-2

INDUSTRIES WITHIN THE AUSTIN METROPOLITAN AREA

Name of Industry	Address	Gallons Water Usage 1969 August	Gallons Water Usage 1969 February	Presently Served by Existing Austin Collection System
1. Jefferson Chemical Co.	7114 N. Lamar	15,632,300	15,630,100	Yes
2. Tracor	4525 Ed. Bluestein	5,747,300	4,463,900	Yes
3. Texas Instruments	8400 Research Blvd.	310,000	-0-	Yes
4. IBM Corporation	11400 FM Rd. 1325	315,800	113,700	Yes
5. Acock Laboratories	2700 East 5th St.	27,400	15,200	Yes
6. American Polystyrene	505 E. Ben White	1,543,600	826,100	Yes
7. Cupples Container Co.	2255 E. Ben White	595,400	29,800	Yes
8. Southwestern Analytical Chemicals	821 Woodward St.	36,000	23,000	Yes
9. Reichhold Chemicals Inc.	260 Reichhold Blvd.	774,600	551,300	Yes
10. Studman Photo Service	5324 Cameron	144,000	135,300	Yes
11. Pure Casting Inc.	2106 East 4th St.	119,900	25,800	Yes
12. Tips Iron and Steel	300 Baylor St.	254,500	248,100	Yes
13. Capital Metal Finishing Co.	3909B Warehouse Row	646,100	457,100	Yes
14. Cen-Tex Plating Co.	215 Industrial Blvd.	197,200	182,100	No
15. Instrument Metal Finishing Co.	310 St. Elmo Rd.	368,500	311,600	No
16. Mat-Ko Matrix Service Co.	2611 Manor Rd.	2,800	400	Yes
17. Texas Industrial Laundries	6000 Bolm Rd.	694,100	687,100	Yes
18. National Linen Service	310 Comal	2,359,000	1,843,800	Yes
19. Main Linen Service	3227 East 5th St.	795,900	530,100	Yes
20. Capitol Laundry	801 Barton Springs Rd.	635,200	623,700	Yes
21. Model Laundry	1110 East 1st St.	392,900	241,600	Yes
22. Travis Laundry	1200 Red River	286,100	226,400	Yes
23. Govalle Laundry	1122 Springdale Rd.	338,600	320,300	No

TABLE A-2 (Cont'd.)

Name of Industry	Address	Gallons Water Usage 1969 August	Gallons Water Usage 1969 February	Presently Served by Existing Austin Collection System
24. Stork Diaper Service	1406 East 38½ St.	328,600	320,400	No
25. Superior Dairies	600 East 1st St.	2,657,000	2,229,100	Yes
26. Capitol Candy Co.	2324 East 1st St.	17,800	–	Yes
27. Lammes Candies	5330 Airport Blvd.	235,300	42,400	Yes
28. Austin Baking Co.	5800 Airport Blvd.	1,565,000	1,097,700	Yes
29. Mrs. Baird's Bakeries	701 Tillery	776,200	440,900	Yes
30. Bruce Baking Co.	801 Springdale Rd.	104,000	96,600	Yes
31. Mrs. Johnson's Bakery	1303 Koenig Lane	125,100	71,800	Yes
32. Barnett's Pie Shop	1516 S. Lamar	75,000	43,000	Yes
33. Peals Sani-Products	1623 Toomey Rd.	472,500	–	Yes
34. L. East Produce Co.	706 East 8th St.	3,133,700	2,181,900	Yes
35. Massengale Co.	80 Red River	780,400	589,400	Yes
36. Austin Meat Co.	3301 East 5th St.	488,600	375,500	Yes
37. Meat Purveyor's Inc.	1701 Toomey Rd.	531,400	–	Yes
38. Armour and Company	215 West 2nd St.	418,900	266,600	Yes
39. Austin Coca Cola Co.	1009 West 6th St.	1,621,800	1,181,000	Yes
40. Pepsi Bottling Co.	2412 East 1st St.	1,617,900	86,300	Yes
41. 7-Up Bottling Co.	3411 Hidalgo	844,400	607,700	Yes
42. Cen-Tex Dr. Pepper	9600 McNeil	864,300	687,500	Yes
43. Grapette Bottling Co.	5005 East 1st St.	164,300	105,100	Yes
44. Royal Crown Bottling Co.	730 Shady Lane	395,600	224,600	Yes
45. Beverages Inc.	5415 N. Lamar	124,300	123,900	Yes

TABLE A-3

RAW WASTEWATER INFLUENT DATA FOR FISCAL YEARS 1964 THROUGH 1969

	Maximum*	Minimum*	Average*
Flow (mgd Ave.)	29.846	19.913	23.723
Free Ammonia	28.0	14.1	21.4
BOD (5-Day)	264	94	161
COD	483	205	357
Suspended Solids	197	69	146
pH	7.7	7.4	7.5
Settleable Solids %	0.98	0.46	0.70
Lbs. per Day BOD	43,166	23,376	35,591
Population Equiv.	253,686	137,510	210,830

****Five year averages.***

Agricultural and Urban Runoff.

The Highland Lakes Report (Phase II, Chapter VI) included a discussion of the pollution potentials of agricultural and urban runoff in most of the CAPCO area. This study presented data indicating that surface runoff contributes a significant amount of pollution to the waters in the study area. It was reported that agricultural runoff is the major contributor of runoff pollution to the waters above and including Lake Austin and that urban runoff is the major contributor of runoff pollution to Town Lake in Austin. Below Austin, the runoff pollution in the Colorado River will consist of both urban runoff pollution from Austin and the cities below Austin and agricultural runoff pollution from the drainage area below Austin.

The principal sources of agricultural runoff pollution include:

- Inorganic fertilizers
- Animal and poultry wastes
- Insecticides and herbicides
- Silt and other suspended solids

The principal factors influencing the concentrations of the pollutants in surface runoff include the amounts of fertilizer, insecticide, and herbicide used; number and concentration of animals in the area; soil conditions; and intensity and duration of rainfall.

The principal sources of urban runoff include:

- Street and parking area litter, debris, oil, and grease droppings from motor vehicles
- Animal and bird droppings deposited on impervious surfaces
- Fertilizers used on lawns and planted areas
- Pesticides
- Suspended material from excavations and construction activities
- Leaves and grass cuttings
- Emissions from industrial activities and motor vehicles which settle or are washed down by rain
- Solids from unpaved streets and newly sprigged or seeded lawns
- Unauthorized discharges into gutters, streets, storm sewers, or creeks
- Overflowing manholes in overloaded sanitary sewer systems

As in the case of agricultural runoff, concentrations of pollutants in urban runoff depend upon the amount of pollutants present which may be washed away by rainwater, time interval since the last rainstorm, and intensity and duration of present and previous rainstorms. In order to compare pollution from agricultural areas with urban areas, a number of samples were taken and analyzed from selected tributaries of the Colorado River. The sampling locations and their representative land-use classifications are given below:

Sampling Location	Principal Land Use Represented
Sandy Creek near Kingsland	Agricultural
Pedernales River near Johnson City	Agricultural
Llano River near Llano	Agricultural
Wilbarger Creek near Pflugerville	Agricultural (some concentrated septic tank areas)
Walnut Creek at F.M. 969	Agricultural and Urban Residential
Waller Creek at 23rd St.	Urban Residential
Waller Creek at 1st St.	Urban Residential and Commercial
Shoal Creek near W. 3rd St.	Urban Residential and Commercial

An attempt was made to collect samples during both low and high flows, although extremely high storm flow data were not obtained for the Pedernales River, Sandy Creek, or Llano River. The analyses show in almost all cases that the flows in the Pedernales and Llano Rivers and Sandy Creek had much lower total and fecal coliform and BOD concentrations than did Walnut, Waller, and Shoal Creeks. On the basis of the limited data obtained, no valid comparison could be made between concentrations of pollutants and streamflow, but they indicated that urban runoff is generally much higher in concentration of pollutants than agricultural runoff.

It was reported that under normal conditions the runoffs from the Llano River and Sandy Creek should not have a significant effect on the water of Lake Lyndon B. Johnson into which they discharge, although these streams were not sampled during periods of extremely high runoff.

Similarly, runoff from the Pedernales River under normal conditions should not have a significant effect upon the quality of Lake Travis.

The data indicated that runoff from Waller and Shoal Creeks may carry extremely high concentrations of pollutants at both high and low flows and have a very significant effect upon water quality in Town Lake into which they discharge. Data were reviewed regarding the total coliform bacteria MPN/100 at the Thomas C. Green Water Treatment Plant intake on Town Lake and the Albert R. Davis Water Treatment Plant intake on Lake Austin. It was noted that the total coliform bacteria count during the same period of study ranged from 3 to 38 times higher in Town Lake than Lake Austin.

Two other factors influencing the quality of water in Town Lake, which apparently prevent the water in Town Lake from becoming extremely degraded, are the volumes of water discharged into Town Lake from Lake Austin by the LCRA and flow from Barton Springs. The capacity of Town Lake is reported to be approximately 3,520 acre-feet, and the average flow discharged from Lake Austin in 1969 reported on a daily basis (total yearly flow divided by 365) was 2,890 acre-feet. Therefore, on an average, in 1969 the water in Town Lake was replaced about every 29 hours due to the discharge from Lake Austin alone.

Proposed Wastewater Systems Considerations.

General Discussion.

The existing and proposed sewage collection systems to serve the greater Austin area throughout the study period are shown on Plate A-2. A major portion of the proposed interceptors and mains were included in the "Capital Improvements Program, 1972-1977" prepared by the City of Austin Planning Commission. For the most part, these proposed improvements are included within this report with little or no alteration.

The project of major importance at present is the Crosstown Interceptor Tunnel which is now under construction. The main purpose of the tunnel is to relieve the existing Govalle treatment plant of the major portion of the area served by the central sewage collection system. Another major factor in its favor is the elimination of an extensive amount of parallel relief sewers to the existing system which would be required in the fully-developed areas of the City. By reducing the area served by the Govalle plant at present, new development taking place south of the Colorado River in south and southeast Austin can be served by the Govalle plant. The Crosstown Tunnel, which will transport sewage to a new sewage treatment plant proposed at the existing Walnut Creek plant site, was also conceived due to the fact that the existing Govalle plant has no area adjacent to the plant site for expansion of existing facilities.

In order for the South Austin Interceptor Sewer to serve areas proposed for development in the Barton and Dellana Creek drainage areas, as well as a portion of West Lake Hills, a parallel relief sewer will be required from the existing 36-inch stub on Barton Creek to the eastern end of the 54-inch line adjacent to the Colorado River just south of and across the river from the Govalle plant.

Design Criteria.

The existing criteria used by the City of Austin Water and Wastewater Department were used in evaluating existing and proposing new sewage collection systems in this report. The older existing systems in the City (Taylor Slough, Johnson Creek, Shoal Creek, Waller Creek, Boggy Creek, Tannehill Branch, Fort View Branch, Bouldin Creek, East Bouldin Creek, Blunn Creek, Harpers Branch, and Tinnin Branch) were evaluated using a design criteria of 3,000 gallons per acre per day. The more recently and sparsely developed areas, and those areas proposed for development, were evaluated using a design cirteria of 2,000 gallons per acre per day (Country Club Gardens, Montopolis, Bergstrom, Little Walnut Creek, Big Walnut Creek, Onion Creek, Williamson Creek, Barton Creek, Dellana Creek, West Lake Hills, Dry Creek, and Bull Creek). All existing and proposed sewers were evaluated and sized, assuming a minimum velocity of two feet per second. Sewage treatment facilities were evaluated and proposed, based on population and a factor of 100 gallons per capita per day.

Topographical Considerations.

As can be seen on Plate A-2, the majority of existing intercepting sewers follow either a creek bank or the Colorado River bank. Almost all streams in this area have enough natural slope to eliminate the necessity of lift stations. This advantage was also utilized in proposing sewage collection facilities for the study area. Another advantage of constructing sewers in this manner is that minimum inconvenience is placed on existing development during construction, and generally it is less costly due to the lack of pavement and utility restoration required when constructing sewers through undeveloped areas.

Construction Scheduling.

The proposed sewage collection facilities shown on Plate A-2 are identified to be constructed by either 1980, 1990, or 2020. It must be emphasized that these time priorities were scheduled based on the projected land use (Plate A-1) and on plans which the City of Austin has at the present time. If development does not occur according to the projected land use, this will change the construction schedule presented. It should be noted also that some of the areas proposed to be served by one of the three major sewerage systems (Govalle, Walnut Creek, or Williamson Creek) may in fact be diverted into the adjacent major sewerage system. The areas which come to light in this respect are the West Lake Hills area, Barton Creek, Dellana Creek, and Williamson Creek. Local development, in addition to political and jurisdictional considerations, may change the service area

boundaries as well as the construction scheduling. In view of these facts, however, the proposed facilities presented herein are believed to represent the most realistic overall system with respect to existing and proposed development, adjacent local communities, topography, the environment, and the present thinking of the officials of the City of Austin at this time.

When considering the construction scheduling with respect to proposed land use, one very important fact must be brought out. The proposed land-use exhibits do not show the "leap-frog" manner in which land is presently developing around Austin and in all metropolitan areas around the country. Subdivisions are developing along the outskirts of the City and in areas previously considered rural. These developments are usually too remote to be served by an existing city sewage collection system. Under these conditions, interim sewage treatment facilities will have to be constructed to serve until such time as the City expands its facilities to within reach of these areas of development.

Population Considerations.

The population projections supplied by the TWQB were for the entire Austin metropolitan area and were not broken down into individual census tracts or drainage basins. In order to evaluate the three existing sewage treatment plants (Walnut Creek, Govalle, and Williamson Creek) and propose any improvements to them, the tributary population to each (both existing and projected) had to be determined.

First, the sewer service area boundaries of the plants were determined, both present and projected to year 2020. The 1980 projected land-use exhibit was then superimposed over these service boundaries, and the amount of developed area within each was determined. The amount of develolpment within each of the three service areas was then expressed as a percentage of the total projected development. Next, the 2020 projected land-use exhibit was superimposed over the projected year 2020 sewer service boundaries and three percentage-of-total-development values were obtained.

The 1980 and 2020 percentage values were then plotted on a graph of percentage versus years and a straight line was drawn between each pair of corresponding points. From this graph, a percentage of development was obtained for each of the three sewer service areas from 1980 to 2020. The projected tributary population for each of the sewage plants was then determined by multiplying the total projected population for the years 1980, 1990, 2000, 2010, and 2020 by the corresponding set of percentage values. The results are shown on Tables A-4 and A-5.

Proposed Collection Systems.

Each proposed collection line shown on Plate A-2 is given one of three major designations, depending on which of the three major sewer areas it is located within (Walnut Creek, Govalle, or Williamson Creek). The proposed sewers tributary to the Walnut Creek sewage treatment plant have the prefix "A"; similarly, those tributary to the Govalle Plant have the prefix "B";

TABLE A-4

PERCENTAGE OF TOTAL DEVELOPED AREA SERVED BY EACH EXISTING CITY OF AUSTIN SEWAGE TREATMENT PLANT FROM 1980 TO 2020

Plant	1980	1990	2000	2010	2020
Walnut Creek	50.3	51.1	51.5	51.8	52.0
Govalle	35.8	33.5	31.2	29.0	27.0
Williamson Creek	13.9	15.4	17.3	19.2	21.0
Total	100.0	100.0	100.0	100.0	100.0

TABLE A-5

PROJECTED POPULATION SERVED BY EACH EXISTING CITY OF AUSTIN SEWAGE TREATMENT PLANT

Plant	1980	1990	2000	2010	2020
Walnut Creek	164,430	219,678	293,550	380,730	474,292
Govalle	117,031	144,017	177,840	213,150	246,267
Williamson Creek	45,439	66,205	98,610	141,120	191,541
Total	326,900	429,900	570,000	735,000	912,100

and those tributary to the Williamson Creek plant have the prefix "C". The main stem of these intercepting sewers terminating at the three treatment plants have this single letter designation. Traveling out from the treatment plant, as main sewers are encountered tributary to the intercepting sewers, these sewers are designated with the prefix letter and a number. For example, if the designation of the intercepting sewer tributary to the Williamson Creek plant is "C," the first main sewer encountered will have the designation "C-1"; the second will be designated "C-2"; and so on. As the breakdown of sewers tributary to the main occurs, these submain sewers will be designated by three figures. Continuing with Williamson Creek as an example, the first submain sewer encountered on the "C-1" main sewer would be designated "C-1-a"; the second "C-1-b"; and so on.

In areas where parallel relief sewers are proposed or where extensions to existing intercepting sewers are proposed, a slight modification of this designation system is used. The same major sewer area prefix is retained; however, it appears as a double letter. For example, the relief sewer proposed for the existing South Austin Intercepting Sewer is designated "BB." The designation still retains the proper prefix letter "B" which means that it is tributary to the Govalle plant (Plant B), the only difference being that it is doubled. The same double prefix designation method is used for the Walnut Creek and Williamson Creek plants (Plants A and C, repectively).

This system of designating the proposed sewage collection lines allows a line to be identified with respect to a major sewer service area at a glance. It also permits individual lines to be broken out of the system for the purpose of identification and/or cost estimating. In summary, lines designated with a single prefix letter refer to proposed intercepting sewers, main sewers, etc., and lines designated with double prefix letters refer to proposed relief sewers and proposed extensions of existing intercepting sewers.

The sewage collection lines shown on Plate A-2 proposed for construction by 1980 include those proposed by the City of Austin under their five-year capital improvements program from 1972 through 1977. The proposed collection systems are discussed below according to which major sewer area they will serve. A detailed breakdown of the line segments with respect to size, length, and estimated cost is also presented.

<u>Walnut Creek Sewer Area (Area A).</u>

One intercepting sewer is proposed for this sewer area, Line A. It will generally follow Big Walnut Creek from the Walnut Creek sewage treatment plant north and terminate about 5,000 feet west of F.M. 1325. The intercepting sewer will have three main sewers tributary to it. The first, designated A-1, will serve the existing sanitary sewer system at at Decker Creek Reservoir where the City of Austin plans to construct recreational facilities. Line A-1-a is proposed to extend to the existing wastewater treatment plant serving the City of Manor. It is proposed to

abandon this existing Manor plant about 1980 and transport all sewage from the community to the Walnut Creek Sewage Treatment Plant. This proposal is in agreement with plans presented for Manor in the Highland Lakes Report.

Main sewer A-2 will serve development in the northern portion of the Big Walnut Creek drainage area along I.H. 35. Line A-2 is also proposed to serve the community of Pflugerville and proposed development between Pflugerville and I.H. 35 by means of a submain sewer designated Line A-2-b. Main sewer A-3 will serve proposed development along F.M. 1325 between Line A and Howard Lane.

The Crosstown Interceptor Tunnel is shown on Plate A-2 as an existing system, although it is still under construction. The tunnel is scheduled for completion some time in 1974, so for the purpose of this report and the proposed systems presented herein, this is a valid assumption. The justification for construction of the tunnel is two-fold: (1) the tunnel will relieve overloaded conditions occurring at times in the North Austin Interceptor Sewer, and (2) the tunnel will provide sewer service to presently-unserved areas in the Dry Creek, Bull Creek, and West Lake Hills area.

The sewer system designated AA-1 will serve proposed development in the Bull Creek drainage area. Line AA-1 will begin at the end of the Crosstown Tunnel at the intersection of F.M. 2222 and Lakewood Drive and travel northward along Bull Creek to its upper extremity in the western portion of the drainage basin. This interceptor sewer will also have a number of main and submain sewers tributary to it to provide service to subareas within the drainage basin.

The major portion of the existing and proposed development in the West Lake Hills area will be served by two intercepting sewers designated AA-2 and AA-3. Line AA-2 will serve most of the existing development north of an imaginary line running east and west just above Tom Miller Dam. Line AA-3 will extend along the western and southern shore of Lake Austin from a point just opposite the water intake structure for the Albert R. Davis Water Treatment Plant, upstream to the River Hills community. A summary of the costs of the proposed Area A sewage collection system is presented in Table A-6.

Govalle Area Proposed Collection System.

The collection system improvements proposed by 1980 for Area B will provide relief to the existing South Austin intercepting sewer and extension of its service area boundaries into the Barton Creek, Dellana Creek, and West Lake Hills areas. Line BB will serve as a parallel relief sewer to the South Austin intercepting sewer and Line BB-1 will extend sewer service into the Barton Creek drainage area. Line BB-1-a will provide service to the southern portion of the Barton Creek drainage area. Line BB-2 will serve all proposed and existing development in the Dellana Creek drainage area, which includes a portion of Rollingwood and West Lake Hills.

TABLE A-6

COLLECTION SYSTEM "A" IMPROVEMENTS

1980 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
A	72	31,000	90.00	$ 2,790,000
	66	24,000	82.50	1,980,000
	42	15,000	61.00	915,000
	30	4,000	50.00	200,000
A-1	12 F.M.	18,000	10.00	180,000
	4 F.M.	5,000	6.00	30,000
A-1-a	12 F.M.	27,000	10.00	270,000
A-2	42	5,000	61.00	305,000
	36	10,000	56.00	560,000
A-2-a	15	4,000	27.00	108,000
	12	4,000	22.00	88,000
A-2-b	21	8,000	36.00	288,000
	18	2,500	30.00	75,000
	15	6,500	27.00	175,500
	12	5,000	22.00	110,000
A-3	24	11,000	41.00	451,000
Lift Station (Manor)				90,000
Lift Station (Decker Creek Reservoir)				15,000
Lift Station (Decker Community)				60,000
AA-1	60	13,500	77.00	1,039,500
	54	18,500	72.00	1,332,000
	42	5,000	61.00	305,000
	30	1,000	50.00	50,000
	24	5,000	41.00	205,000
	15	8,000	27.00	216,000
AA-1-a	42	4,000	61.00	244,000
	36	5,500	56.00	308,000
	24	1,800	41.00	73,800
AA-1-c	21	5,000	36.00	180,000
	18	4,000	30.00	120,000
	12	6,000	22.00	132,000
	10	4,000	19.00	76,000
AA-1-d	12	7,000	22.00	154,000
	10	5,000	19.00	95,000

TABLE A-6 (Cont'd.)

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
AA-1-e	30	4,500	50.00	$ 225,000
	21	5,500	36.00	198,000
	18	3,000	30.00	90,000
AA-1-e-1	15	5,000	27.00	135,000
AA-1-f	27	4,000	46.00	184,000
	18	5,000	30.00	150,000
	12	4,000	22.00	88,000
AA-2	21	12,500	36.00	450,000
	18	3,500	30.00	105,000
	15	3,000	27.00	81,000
	12	3,000	22.00	66,000
	10	3,000	19.00	57,000
AA-3	30	11,500	50.00	575,000
	27	5,500	46.00	253,000
	24	5,500	41.00	225,500
	21	3,000	36.00	108,000
	18	8,000	30.00	240,000
	15	8,000	27.00	216,000
	12	4,000	22.00	88,000
AA-3-a	12	6,000	22.00	132,000
			Subtotal	$16,887,300
			Engineering and Contingencies	2,685,000
			1980 Total	$19,572,300

ANNUAL O&M COSTS

1)	Collection System (Assume 50-year life, 2% replacement cost)	$ 334,400
2)	Lift Stations	8,000
	1980 Total Annual Cost	$ 342,400

1990 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
AA-1-a-1	21	3,500	36.00	$ 126,000
	18	3,500	30.00	105,000
	15	3,500	27.00	94,500
			Subtotal	$ 325,500
			Engineering and Contingencies	62,800
			1990 Total	$ 388,300

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
SEP 73

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2 OF 5
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TABLE A-6 (Cont'd.)

ANNUAL O&M COSTS

1)	Collection	$ 340,900
2)	Lift Stations	8,000
	1990 Total Annual Cost	$ 348,900

2020 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
AA-1-a	15	5,500	27.00	$ 148,500
	12	3,000	22.00	66,000
AA-1-a-2	15	5,000	27.00	135,000
	12	4,000	22.00	88,000
AA-1-b	15	2,000	27.00	54,000
	12	5,000	22.00	110,000
AA-1-f-1	15	7,000	27.00	189,000
AA-1-g	15	7,000	27.00	189,000
	12	5,500	22.00	121,000
AA-1-h	15	7,000	27.00	189,000
			Subtotal	$ 1,289,500
			Engineering and Contingencies	223,000
			2020 Total	$ 1,512,500

ANNUAL O&M COSTS

1)	Collection System	$ 366,700
2)	Lift Stations	8,000
	2020 Total Annual Cost	$ 374,700

Line BB-2-a will provide service to the remainder of West Lake Hills and Rollingwood not to be served by Lines BB-2 or AA-2. The estimated costs of the improvements proposed for Area B are presented in Table A-7

Williamson Creek Area Proposed Collection System.

An intercepting sewer (Line C) is proposed along Onion Creek which will provide service to existing and proposed development along Onion Creek, Slaughter Creek, and Boggy Creek within the Onion Creek drainage area. Line C-1 is a main sewer proposed to serve development along Boggy Creek. Lines C-2 and C-2-a will provide service to the community of Manchaca and other development along Slaughter Creek. Line CC-1 is a proposed extension of the existing interceptor serving development adjacent to Williamson Creek. This proposed interceptor will provide service to future development along Williamson Creek as well as development in the Oak Hill area. The estimated costs of these improvements is given in Table A-8.

Onion Creek Area Proposed Intercepting Sewer.

This intercepting sewer (Line D), proposed by 1980 along Onion Creek between the existing Williamson Creek plant and the proposed Onion Creek plant (see Plate A-2), will transport the projected wastewater flows to the Williamson Creek plant site as well as flow from proposed areas of development along Onion Creek. The estimated costs of this system is given in Table A-9.

Parallel Relief Sewers.

In addition to proposed new intercepting sewers to serve areas which are presently developing or which are proposed to develop in the future, there is also a considerable amount of relief sewer construction needed. These proposed relief sewers, shown on Plate A-2, are the major facilities needed at present to relieve older intercepting sewers, although they are shown to be constructed by 1980. The proposed relief sewers are presented in Table A-10 with the estimated cost of their construction and total annual O&M cost. Table A-11 presents a total summary of the proposed collection system improvements which includes the major trunk sewers, mentioned previously, and the parallel relief sewers. This summary represents the total anticipated required investment in the collection system for major construction.

Proposed Wastewater Treatment Facilities.

This portion of the report presents the different alternatives for sewage treatment in the Austin metropolitan area throughout the study period. The first set of alternatives (Alternatives A-1 and A-2) presents plans for meeting the requirements of PL 92-500 by means of a phased

TABLE A-7

COLLECTION SYSTEM "B" IMPROVEMENTS

1980 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
BB	54	27,500	72.00	$1,980,000
	60	6,000	77.00	462,000
	30	6,500	50.00	325,000
	36	2,000	56.00	112,000
BB-1	48	14,500	67.00	971,500
	42	11,000	61.00	671,000
	36	8,000	56.00	448,000
	30	1,500	50.00	75,000
	18	5,000	30.00	150,000
	15	6,000	27.00	162,000
BB-1-a	24	7,500	41.00	307,500
	21	3,000	36.00	108,000
	18	3,000	30.00	90,000
	15	3,500	27.00	94,500
BB-2	24	9,000	41.00	369,000
	21	6,000	36.00	216,000
	18	5,500	30.00	165,000
	15	2,000	27.00	54,000
	12	2,000	22.00	44,000
BB-2-a	24	5,500	41.00	225,500
	21	3,000	36.00	108,000
	18	5,000	30.00	150,000
	15	1,000	27.00	27,000
	12	2,000	22.00	44,000
	10	3,000	19.00	47,000
			Subtotal	$7,416,000
			Engineering and Contingencies	$1,201,400
			1980 Total	$8,617,400

ANNUAL O&M COST

1980 Collection System* Annual Cost $ 148,300

**Assume 50-year life, 2% replacement cost.*

TABLE A-8

COLLECTION SYSTEM "C" IMPROVEMENTS
1980 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
C	60	13,000	77.00	$1,001,000
	54	11,000	72.00	792,000
	36	8,500	56.00	476,000
	30	4,000	50.00	200,000
	27	4,500	46.00	207,000
C-1	30	8,000	50.00	400,000
	27	3,500	46.00	161,000
	24	2,500	41.00	102,500
	21	3,000	36.00	108,000
	18	5,500	30.00	165,000
	15	2,500	27.00	67,500
C-2	36	7,500	56.00	420,000
	24	5,000	41.00	205,000
	21	2,000	36.00	72,000
	18	6,000	30.00	180,000
	15	5,500	27.00	148,500
C-2-a	24	4,000	41.00	164,000
	21	1,500	36.00	54,000
	18	4,000	30.00	120,000
	15	1,500	27.00	40,500
CC-1	36	5,500	56.00	308,000
	27	5,500	46.00	253,000
	24	7,000	41.00	287,000
	18	3,000	30.00	90,000
	12	2,500	22.00	55,000
CC-1-a	18	4,000	30.00	120,000
	15	3,000	27.00	81,000
			Subtotal	$6,278,000
			Engineering and Contingencies	$1,023,300
			1980 Total	$7,301,300

ANNUAL O&M COSTS

1980 Collection System* Total Annual Cost	$ 125,500

***Assume 50-year life, 2% replacement cost.**

TABLE A-8 (Cont'd.)

1990 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
C	27	5,000	46.00	$ 230,000
			Engineering and Contingencies	46,000
			1990 Total	$ 276,000

ANNUAL O&M COSTS

Collection System	1990 Total Annual Cost	$ 4,600

TABLE A-9

COLLECTION SYSTEM "D" IMPROVEMENTS

1980 CAPITAL CONSTRUCTION COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
D	78	60,000	97.50	$5,850,000
			Subtotal	$5,850,000
			Engineering and Contingencies	953,500
			1980 Total	$6,803,500

ANNUAL O&M COSTS

1980 Collection System* Total Annual Cost	$ 117,000

****Assume 50-year life, 2% replacement.***

TABLE A-10

1980 RELIEF SEWER CAPITAL COSTS

Line	Size (in.)	Length (ft.)	Unit Cost ($/L.F.)	Cost
BB-6 (Country Club Creek	21	4,500	36.00	$ 162,000
Relief Interceptor)	24	6,500	41.00	266,500
			Subtotal	$ 428,500
			Engineering and Contingencies	79,300
			Subtotal	$ 507,800
CC-2 (Turtle Creek Relief	12	6,000	22.00	$ 132,000
Main)			Engineering and Contingencies	27,700
			Subtotal	$ 159,700
AA-3 (Boggy Creek Relief	36	9,500	56.00	$ 532,000
Interceptor)			Engineering and Contingencies	98,400
			Subtotal	$ 630,400
AA-4 (Shoal Creek Relief	42	9,000	61.00	$ 549,000
Interceptor)	36	11,500	56.00	644,000
	24	5,000	41.00	205,000
			Subtotal	$1,398,000
			Engineering and Contingencies	243,200
			Subtotal	$1,641,200
BB-5 (Thompson Lane	8	4,500	14.00	$ 63,000
Interceptor)			Engineering and Contingencies	13,900
			Subtotal	$ 76,900
AA-6 (Tannehill Branch Main)	12	5,000	22.00	$ 110,000
			Engineering and Contingencies	23,100
			Subtotal	$ 133,100
AA-5 (Waller Creek Relief	24	1,500	41.00	$ 61,500
Interceptor)	15	10,000	27.00	270,000
			Subtotal	$ 331,500
			Engineering and Contingencies	55,000
			Subtotal	$ 386,500
BB-4 (North Austin Outfall	30	3,500	50.00	$ 175,000
Relief Interceptor)			Engineering and Contingencies	35,000
			Subtotal	$ 210,000
			1980 Total Relief Sewer Cost	$3,745,600
			1980 Total Annual O&M Cost*	$ 63,400

**Assumes 50-year life, 2% replacement cost.*

TABLE A-11

PROPOSED COLLECTION SYSTEM IMPROVEMENTS

Year	System	Capital Cost*	Annual O & M
1980	"A"	$19,572,300	$ 342,400
1980	"B"	8,617,400	148,300
1980	"C"	7,301,300	125,500
1980	"D"	6,803,500	117,000
1980	Parallel Relief Systems	3,745,600	63,400
	Total	$46,040,100	$ 796,600
1990	"A"	$ 388,300	$ 6,500
1990	"B"	276,000	$ 4,600
	Total	$ 664,300	$ 11,100
2020	"A"	$ 1,512,500	$ 25,800

**Includes Engineering and Contingencies.*

implementation of wastewater treatment processes (See Appendix A at the conclusion of the CAPCO discussion.) These plans consider both the operation of three sewage treatment plants as well as the abandonment of the facilities, with the treatment of all sewage at one central or regional sewage treatment plant. The method of secondary treatment is assumed to be activated sludge, since all three Austin plants presently use this process. The second set of alternatives (Alternatives B-1 through B-10) presents plans for meeting a "highest level of treatment" objective which would have no constraints on the renovated water use.

Cost functions considering capital costs and annual O&M costs are also presented for each set of alternatives. Prior to presentation of the proposed wastewater treatment facility alternatives it should be noted that proposed collection systems costs and parallel relief systems costs are common to each alternative, and these costs are repeated for all alternatives. Likewise, proposed sewer interceptor systems costs are common to each regional alternative and these costs are repeated for all regional alternatives. A more detailed economic analysis for each alternative is shown in Appendix C of this section.

Alternative A-1.

This plan is prepared to meet the minimum treatment objectives of PL 92-500. The plan proposes upgrading the effluent quality and treatment capacity of the existing Walnut Creek Wastewater Treatment Plant, upgrading the effluent quality of Govalle Wastewater Treatment Plant, constructing new wastewater treatment facilities at Onion Creek, upgrading the treatment capacity of the existing Williamson Creek Wastewater Treatment Plant, and abandoning the Williamson Creek plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of secondary treatment and tertiary treatment proposed is activated sludge.

Walnut Creek Wastewater Treatment Plant.

A study was made for the City of Austin in 1971, entitled "Report on Wastewater Treatment Walnut Creek Site for Austin, Texas," by Black and Veatch, Consulting Engineers, and S.A. Garza Engineers, Inc. The purpose of the study was to provide a basis for design and cost estimates for expansion of the wastewater treatment facilities at the Walnut Creek plant site. As mentioned previously, these facilities will serve the Walnut Creek drainage basin and contiguous areas as well as the superimposed load from the Crosstown Interceptor Tunnel. Construction of the first increment of the plant, having a design flow of 18 mgd, is proposed to be completed some time in 1975.

Envisioned for this facility by the report is the inclusion of pretreatment facilities at the plant. The proposed pretreatment facilities will consist of flow measurement, screening, grit removal, primary sedimentation, and a flow equalization storage lagoon.

Flow will be measured by two Parshall flumes, each with a 4-foot throat width. One flume will operate over a flow range between minimum flow and 76 mgd, with both flumes operating when the flow exceeds 76 mgd. Two mechanically-cleaned bar screens will provide screening. Two aerated grit chambers will be provided, with both units operating at all times. The flow from the aerated grit chambers will be equally split and will flow to two center feed primary sedimentation units. Equalization of flow to the secondary treatment process will be provided. The purpose of the flow equalization basin is to provide increased ease of operation and reliability of the secondary process.

The nominal design of the preliminary treatment units is 27 mgd. A statistical analysis of data from the Govalle plant showed the maximum day flow to be 1.33 times the mean annual flow. A mass-flow diagram was prepared from the daily flow charts at the Govalle plant, and the amount of storage required to provide a constant outflow from the flow equalization basin was found to be 14.5 percent of the total flow for a given day. The flow equalization volume to be provided for a mean annual flow rate of 27 mgd was reported to be 1.33 times 14.5 percent times 27 mgd, or 5.4 million gallons. This volume will be provided in two equal-size basins.

In the report several alternatives for secondary treatment were studied, including (a) biological, (b) biological with alum addition, (c) biological with lime addition, (d) physical-chemical with and without recalcining lime sludge, and (e) physical-chemical with carbon absorption. The biological treatment was determined to be the most economical process to meet a 20/20 quality criteria, and the biological process with alum addition was determined to be the most economical process to meet a possible future criteria of 5/5/1. Reduction of BOD/SS to a level of 10/10 was reported to be accomplished most economically by adding filters to the biological process.

It was also recommended that if nitrification was required, this should be accomplished by increasing sludge detention time and oxygen transfer rate. Nitrogen removal, if required, should be accomplished by adding an ammonia stripping tower following the lime precipitation basins. COD removal should be accomplished by adding granular carbon adsorbers between the filtration and chlorination facilities.

The City of Austin at present is planning to construct the first increment of the biological secondary treatment plant and preliminary treatment facilities by the end of 1975. Although the population projections used for the design of the Walnut Creek plant described above are different from those utilized in this report, they are in close agreement through 1984, which is the design life of the first increment of the proposed plant (18 mgd). Using projected population and a design criteria of 100 gallons per person per day, the required treatment capacity for the Walnut Creek plant follows:

WALNUT CREEK

Population and Flow Projections

	1970[1]	1980	1990	2000	2010	2020
Population	111,700	164,430	219,335	294,975	385,728	485,237
Plant Capacity, mgd	1.4	16.4	21.9	29.5	38.6	48.5

When the above data are plotted on a graph, the required treatment capacity for 1983 is 18.0 mgd. The required capacity for 2020 is shown to be 48.5 mgd, or an increase of approximately 30.5 mgd. If two incremental expansions of approximately 15 mgd each are assumed (the first 15-mgd incremental expansion constructed in 1983) the total capacity of 33 mgd would be adequate until year 2003, at which time construction of the second expansion of 15 mgd would be adequate to year 2020. The first increment of expansion would serve for 20 years before requiring relief capacity and the second increment of expansion would similarly serve for 17 years.

If, instead of proposing two equal increments of expansion, three equal increments of approximately 10 mgd were assumed, the average service life (before requiring expansion) of each would be 12.5 years (15, 12, and 10 years respectively). The design period is more in keeping with actual design periods normally experienced for wastewater treatment facilities. Therefore, it is recommended that by 1983, an expansion with a capacity of 10 mgd be constructed at the Walnut Creek plant (assumed to have a capacity of 18 mgd). By 1998, a second 10-mgd expansion would be required, and the third 10-mgd expansion, required by 2010, would be adequate until year 2020.

By 1983, the Walnut Creek plant should have partial tertiary treatment, including partial filtration, nitrification, and phosphorus removal as described in the rational for phased implementation of wastewater treatment processes. Therefore, in addition to the 10-mgd secondary treatment expansion, units should be constructed to provide the degree of treatment necessary to meet the 1983 effluent requirements set forth in this report. Similarly, the two other 10-mgd secondary treatment plant expansions, proposed for years 1998 and 2010, should also include the necessary treatment units to meet the effluent requirements of this report which includes nitrification, denitrification, phosphorus removal, and total filtration. The facilities proposed for the Walnut Creek plant along with estimates of cost are summarized in Table A-12.

[1]Black & Veatch and S.A. Garza, 1971.

TABLE A-12

WALNUT CREEK COST SUMMARY

Capital Costs

Year	Item of Construction	Estimated Cost
1975	Construct Secondary Facilities (18 mgd)	$4,800,000
1975	Engineering and Contingencies	787,200
	Subtotal	$5,587,200
1983	Expand Secondary Facilities (10 mgd)	$3,000,000
1983	Construct Nitrification Unit (28 mgd)	2,000,000
1983	Construct Filtration Plant (19 mgd)	700,000
1983	Construct Phos. Removal Fac. (28 mgd)	90,000
1983	Engineering and Contingencies	943,700
	Subtotal	$6,733,700
1985	Construct Denitrification Unit (28 mgd)	$1,900,000
1985	Expand Filtration Plant (9 mgd)	440,000
1985	Engineering and Contingencies	393,100
	Subtotal	$2,733,100
1998	Expand Secondary Facilities (10 mgd)	$3,000,000
1998	Expand Nitrification Unit (10 mgd)	950,000
1998	Expand Denitrification Unit (10 mgd)	850,000
1998	Expand Filtration Plant (10 mgd)	440,000
1998	Expand Phos. Removal Facilities (10 mgd)	60,000
1998	Engineering and Contingencies	863,900
	Subtotal	$6,163,900
2010	Expand Secondary Facilities (10 mgd)	$3,000,000
2010	Expand Nitrification Unit (10 mgd)	950,000
2010	Expand Denitrification Unit (10 mgd)	850,000
2010	Expand Filtration Plant (10 mgd)	440,000
2010	Expand Phos. Removal Facilities (10 mgd)	60,000
2010	Engineering and Contingencies	863,900
	Subtotal	$6,163,900

Annual O&M Costs

Year	Unit or Facilities	Annual Cost
1975	Secondary Facilities (18 mgd)	$ 427,000
1983	Secondary Facilities (28 mgd)	643,800
1983	Nit. and Phos. Units (28 mgd)	864,600
1983	Filtration Units (19 mgd)	152,500
1985	Secondary Facilities (28 mgd)	643,900
1985	Tertiary Facilities (28 mgd)	1,345,000
1998	Secondary Facilities (38 mgd)	832,200
1998	Tertiary Facilities (38 mgd)	1,713,000
2010	Secondary Facilities (48 mgd)	1,051,200
2010	Tertiary Facilities (48 mgd)	2,084,900

Govalle Wastewater Treatment.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

GOVALLE

Population and Flow Projections

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated combined population served by Govalle and Williamson Creek Plants.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Partial tertiary treatment facilities should be constructed at the Govalle plant by 1983 including partial filtration, nitrification, and phosphorus removal. By 1985 denitrification and additional filtration capacity should be added to serve throughout the study period. The estimated costs and phasing of these proposed improvements is presented in Table A-13.

TABLE A-13

GOVALLE COST SUMMARY

Capital Costs

Year	Item of Construction	Estimated Cost
1983	Construct Filtration Plant (17.3 mgd)	$ 680,000
1983	Construct Nitrification Unit (26 mgd)	1,900,000
1983	Construct Phos. Removal Facilities (26 mgd)	85,000
1983	Engineering and Contingencies	442,400
	Subtotal	$3,107,400
1985	Construct Denitrificatin Unit (26 mgd)	$1,800,000
1985	Expand Filtration Plant (8.7 mgd)	420,000
1985	Engineering and Contingencies	373,000
	Subtotal	$2,623,000

Annual O&M Costs

Year	Unit or Facilities	Annual Cost
1983	Secondary Facilities (26 mgd)	$ 607,400
1983	Filtration Unit (17.3 mgd)	145,200
1983	Nit. and Phos. Facilities (26 mgd)	816,100
1985	Secondary Facilities (26 mgd)	607,400
1985	Tertiary Facilities (26 mgd)	1,271,600

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility further downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The projected populations of these areas are given below:

WILLIAMSON CREEK

Population and Flow Projections

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek		2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at the present time to provide service until 1980, at which time it is proposed to construct the Onion Creek plant. Due to its planned abandonment, the Williamson Creek plant will not require tertiary treatment facilities.

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. Further discussion of the proposed Onion Creek facility is included in the next section of this report.

An estimate of the costs of the proposed facilities for the Williamson Creek Wastewater Treatment Plant is presented in Table A-14.

TABLE A-14

WILLIAMSON CREEK COST SUMMARY

1975 Capital Cost	
Expand Secondary Facilities (4.5 mgd)	$100,000
Engineering and Contingencies	21,600
1975 Total	$121,600
1975 Annual O&M Cost	
Secondary Treatment Facilities (4.5 mgd)	$140,000

Proposed Onion Creek Wastewater Treatment Plant.

The proposed Onion Creek plant will require partial tertiary treatment by 1983 which will include partial filtration, nitrification, and phosphorous removal. By 1985 denitrification and additional filtration facilities will be required. The estimated costs and phasing of these proposed improvements is presented in Table A-15.

TABLE A-15

ONION CREEK COST SUMMARY

Capital Costs

Year	Item of Construction	Estimated Cost
1980	Construct Secondary Facilities (8 mgd)	$2,600,000
1980	Engineering and Contingencies	434,200
	Subtotal	$3,034,200
1983	Construct Nitrification Unit (6.8 mgd)	700,000
1983	Construct Filtration Unit (5.3 mgd)	310,000
1983	Construct Phos. Removal Facilities (6.8 mgd)	52,000
1983	Engineering and Contingencies	185,800
	Subtotal	$1,247,800
1985	Expand Nitrification Unit (7.2 mgd)	$ 720,000
1985	Construct Denitrification Unit (14 mgd)	1,100,000
1985	Expand Filtration Unit (8.7 mgd)	420,000
1985	Expand Phos. Removal Facilities (7.2 mgd)	53,000
1985	Engineering and Contingencies	385,200
	Subtotal	$2,678,200
1994	Expand Secondary Facilities (6 mgd)	$2,000,000
1994	Engineering and Contingencies	338,000
	Subtotal	$2,338,000
2009	Expand Secondary Facilities (6 mgd)	$2,000,000
2009	Expand Nitrification Unit (6 mgd)	640,000
2009	Expand Denitrification Unit (6 mgd)	600,000
2009	Expand Expand Filtration Unit (6 mgd)	320,000
2009	Expand Expand Phos. Removal Facilities (6 mgd)	50,000
2009	Engineering and Contingencies	599,200
	Subtotal	$4,209,200

Annual O&M Costs

Year	Unit or Facilities	Annual Cost
1980	Secondary Facilities (8 mgd)	$ 219,000
1983	Secondary Facilities (8 mgd)	219,000
1983	Nitrification Unit (6.8 mgd)	45,170
1983	Phos. Removal Unit (6.8 mgd)	235,790
1983	Filtration Unit (5.3 mgd)	75,440
1985	Secondary Facilities (8 mgd)	219,000
1985	Tertiary Facilities (14 mgd)	779,200
1994	Secondary Facilities (14 mgd)	347,500
1994	Tertiary Facilities (14 mgd)	779,200
2009	Secondary Facilities (20 mgd)	474,500
2009	Tertiary Facilities (20 mgd)	1,036,600

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

Alternative A-2.

This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants and treating all sewage at one central or regional sewage treatment plant located at Onion Creek. The method of secondary treatment and tertiary treatment proposed is activated sludge. The site assumed for the regional plant is the proposed Onion Creek plant location, since it would be downstream from all three existing plants and it would be fairly equidistant from both the Govalle and Walnut Creek plants. The estimated costs of the two gravity interceptor sewers which would transport sewage from the Govalle and Walnut Creek plants to the proposed Onion Creek plant are presented in Table A-15 and summarized in Table A-16. Again, it should be noted that the proposed interceptor sewer systems costs are common to each regionalization alternative and these costs are repeated for all such regionalization alternatives.

TABLE A-16

INTERCEPTOR SEWER SYSTEMS
REGIONALIZATION ALTERNATIVE

Govalle Interceptor

Construction Item		Capital Cost	Annual Cost
Raw Wastewater Pumping (90 mgd) (at Govalle Plant)		$1,500,000	$ 70,000
Interceptor Sewer, Govalle to Prop. Onion Creek Plant Site:		2,985,000	59,700
9,000 ft., 72-inch sewer	$ 810,000		
18,000 ft., 90-inch sewer	2,025,000		
3,000 ft., 60-inch F.M.	150,000		
Subtotal	$2,985,000		
Siphon Under Colorado River		180,000	3,600
Lift Station (90 mgd)		2,400,000	100,000
Engineering and Contingencies		1,144,500	
Total		$8,209,500	$233,300

Walnut Creek Interceptor

Construction Item		Capital Cost	Annual Cost
Raw Wastewater Pumping (170 mgd) (at Walnut Creek Plant)		$2,300,000	$130,000
Interceptor Sewer, Walnut Creek to Prop. Onion Creek Plant Site:		4,440,000	88,800
24,000 ft., 108-inch sewer	$3,240,000		
10,000 ft., 96-inch sewer	1,200,000		
Subtotal	$4,440,000		
Siphon Under Colorado River		338,000	6,700
Siphon Under Onion Creek		518,000	10,300
Engineering and Contingencies		1,230,500	
Total		$8,826,500	$235,900

TABLE A-17

INTERCEPTOR SEWER SYSTEMS
REGIONALIZATION ALTERNATIVE

Summary Costs

Interceptor		Capital Cost	Annual Cost
Govalle Interceptor		$ 8,209,500	$233,300
Walnut Creek Interceptor		8,826,500	235,900
	Totals	$17,036,000	$469,200

Under the regional concept the ultimate size of the Onion Creek regional plant would be about 90 mgd by year 2020, based on population projections. It will be assumed that the plant would be built in three increments, beginning with a 40-mgd plant at present (by 1975) which would be adequate until about year 1988. At that time a 25-mgd expansion would be adequate until 2005, when a second expansion of 25 mgd would be adequate until 2020. Costs for the treatment facilities associated with this alternative are presented in Table A-18.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-18

ONION CREEK REGIONAL PLANT COST SUMMARY

Capital Costs

Year	Item of Construction	Estimated Cost
1975	Construction Secondary Facilities (40 mgd)	$ 9,000,000
1975	Engineering and Contingencies	1,449,000
	Subtotal	$10,449,000
1983	Construct Nitrification Unit (40 mgd)	2,700,000
1983	Construct Filtration Unit (26.6 mgd)	900,000
1983	Construct Phos. Removal Fac. (40 mgd)	100,000
1983	Engineering and Contingencies	610,500
	Subtotal	$ 4,310,500
1985	Expand Secondary Facilities (25 mgd)	$ 6,000,000
1985	Construct Denitrification Unit (65 mgd)	3,800,000
1985	Expand Filtration Unit (38.4 mgd)	1,170,000
1985	Expand Nitrification Unit (25 mgd)	1,850,000
1985	Expand Phos. Removal Fac. (25 mgd)	85,000
1985	Engineering and Contingencies	2,096,600
	Subtotal	$15,001,600
2005	Expand Secondary Facilities (25 mgd)	$ 6,000,000
2005	Expand Nitrification Unit (25 mgd)	1,850,000
2005	Expand Denitrification Unit (25 mgd)	1,700,000
2005	Expand Filtration Unit (25 mgd)	800,000
2005	Expand Phos. Removal Fac. (25 mgd)	85,000
2005	Engineering and Contingencies	1,669,600
	Subtotal	$12,104,600

Annual O&M Cost

Year	Unit or Facilities	Annual Cost
1975	Secondary Facilities	$ 876,000
1983	Secondary Facilities (40 mgd)	876,000
1983	Nitrification and Phos. Units (40 mgd)	1,146,100
1983	Filtration Unit (26.6 mgd)	184,400
1985	Secondary Facilities (65 mgd)	1,376,000
1985	Tertiary Facilities (65 mgd)	2,657,200
2005	Secondary Facilities (90 mgd)	1,839,600
2005	Tertiary Facilities (90 mgd)	3,498,500

Plans to Meet Highest Level of Treatment.

This section will discuss twelve alternative methods of obtaining the highest level of treatment for the Austin metropolitan area. The first six alternatives, (Alternatives B-1, B-2, B-3, B-4A, B-4B, and B-4C), include biological and physical-chemical methods of treatment and will be discussed for each of the three existing Austin sewage treatment plants separately, as well as for the regional sewage treatment plant scheme considered previously. Alternative treatment methods, (Alternative B-5 through Alternative B-10), considered combinations of biological and physical-chemical secondary treatment along with the two land disposal methods for tertiary treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be accomplished at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County, locating suitable soil types for the three methods of land disposal, and analyzing the anticipated land-use projections. The rapid infiltration method of land disposal was later dismissed from consideration due to lack of required soil information and the apparent short renovative distance and travel time available in those soil series found in Travis County.

The sizing and phasing of the proposed secondary treatment facilities as given in the previous section are assumed here. The difference, of course, is in the methods of treatment.

The cost functions considering capital costs and annual O&M costs are also presented for each set of alternatives. Prior to presentation of the proposed wastewater treatment facility alternatives, it should be noted that proposed collection systems costs and parallel relief systems costs are common to each alternative and these costs, for convenience, are repeated for all alternatives. Likewise, proposed sewer interceptor systems costs are common

to each regional alternative and these costs are repeated for all regional alternatives. A more detailed economic analysis for each alternative is presented in Appendix C of this section.

Alternative B-1.

This plan proposes: (a) upgrading the effluent quality and increasing the treatment capacity of the existing Walnut Creek Wastewater Treatment Plant and the effluent quality of the existing Govalle Wastewater Treatment Plant; (b) constructing new wastewater treatment facilities at Onion Creek; and (c) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment proposed is a biological treatment process (activated sludge), and includes nitrification, denitrification, filtration, activated carbon treatment, chlorination and aeration. The facilities proposed along the estimates of cost are summarized in Table A-19.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-19.

Govalle Wastewater Treatment Plant.

As mentioned previously, the Govalle plant will not require any expansion to its secondary treatment facilities because of the reduction in service area due to the Crosstown Interceptor Tunnel. Therefore, under this alternative, the highest level of treatment would be obtained by upgrading of the existing facilities. Costs for the improvements to this facility are also summarized in Table A-19. The design capacity will be assumed to be 26 mgd, and this capacity should be adequate throughout the study period.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of the proposed facilities at the Williamson Creek and Onion Creek Wastewater Treatment Plants are presented in Table A-19.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	1980	Year 1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-19

ALTERNATIVE B-1
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Facilities (18 mgd)	$12,500,000	$1,642,500
1975	Engineering and Contingencies	2,000,000	
	Total	$14,500,000	$1,642,000
1983	Expand Biological Facilities (10 mgd)	$ 8,000,000	$2,350,600
1983	Engineering and Contingencies	1,288,000	
	Total	$ 9,288,000	$2,350,600
1998	Expand Biological Facilities (10 mgd)	$ 8,000,000	$3,051,400
1998	Engineering and Contingencies	$ 1,288,000	
	Total	$ 9,288,000	$3,051,400
2010	Expand Biological Facilities (10 mgd)	$ 8,000,000	$3,679,200
2010	Engineering and Contingencies	1,288,000	
	Total	$ 9,288,000	$3,679,200

GOVALLE TREATMENT PLANT

1975	Upgrade Existing Unit to Highest Level of Biological Treatment	$10,000,000	$2,182,700
1975	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$2,182,700

WILLIAMSON CREEK TREATMENT PLANT

1975	Expand Secondry Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000

PROPOSED ONION CREEK TREATMENT PLANT

1980	Construct Highest Level Biological Facility (8 mgd)	$ 7,000,000	$ 876,000
1980	Engineering and and Contingencies	1,134,000	
	Total	$ 8,134,000	$ 876,000
1994	Expand Biological Facilities (6 mgd)	$ 5,600,000	$1,328,600
1994	Engineering and Contingencies	912,800	
	Total	$ 6,512,800	$1,328,600
2009	Expand Biological Facilities (6 mgd)	$ 5,600,000	$1,752,000
2009	Engineering and Contingencies	912,800	
	Total	$ 6,512,800	$1,752,000

Alternative B-2.

This plan proposes: (a) upgrading the effluent quality and increasing the treatment capacity of the existing Walnut Creek Wastewater Treatment Plant and the effluent quality of the existing Govalle Wastewater Treatment Plant; (b) constructing new wastewater treatment facilities at Onion Creek; and (c) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment proposed is a biological treatment process (trickling filter), and includes nitrification (using trickling filter), denitrification, filtration, activated carbon treatment, chlorination, and aeration. The facilities proposed, along with estimates of cost, are summarized below and in Table A-20.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-20

Govalle Wastewater Treatment Plant.

This alternative is similar to the previous one (Alternative B-1) with the general difference being substitution of trickling filters for activated sludge units in the nitrification process. The design capacity is assumed to be 26 mgd as before. Costs for this alternative are shown in Table A-20.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of the proposed facilities at the Williamson Creek and Onion Creek Wastewater Treatment Plants are presented in Table A-20.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Year 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-20

ALTERNATIVE B-2
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Facilities (18 mgd)	$17,000,000	$1,182,600
1975	Engineering and Contingencies	2,686,000	
	Total	$19,686,000	$1,182,600
1983	Expand Biological Facilities (10 mgd)	$10,000,000	$1,635,200
1983	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$1,635,200
1998	Expand Biological Facilities (10 mgd)	$10,000,000	$2,080,500
1998	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$2,080,500
2010	Expand Biological Facilities (10 mgd)	$10,000,000	$2,540,400
2010	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$2,540,400
	GOVALLE TREATMENT PLANT		
1975	Upgrade Existing Unit to Highest Level of Biological Treatment	$23,000,000	$1,537,400
1975	Engineering and Contingencies	3,634,000	
	Total	$26,634,000	$1,537,400
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT PLANT		
1980	Construct Highest Level Biological Facility (8 mgd)	$ 8,000,000	$ 671,600
1980	Engineering and Contingencies	1,296,000	
	Total	$ 9,296,000	$ 671,600

1994	Expand Biological Facilities (6 mgd)	$ 6,500,000	$ 970,900
1994	Engineering and Contingencies	1,053,000	
	Total	$ 7,553,000	$ 970,900
2009	Expand Biological Facilities (6 mgd)	$ 6,500,000	$ 1,277,500
2009	Engineering and Contingencies	1,053,000	
	Total	$ 7,553,000	$ 1,277,500

Alternative B-3.

This plan proposes: (a) upgrading the effluent quality and treatment capacity of the existing Walnut Creek Wastewater Treatment Plant; (b) upgrading the effluent quality of the existing Govalle Wastewater Treatment Plant; (c) constructing new wastewater treatment facilities at Onion Creek; and (d) increasing capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment is a physical-chemical treatment process, and includes high lime treatment, neutralization with carbon dioxide, ammonia stripping, denitrification, activated carbon treatment, chlorination and aeration. The facilities proposed along with estimates of cost are summarized in Table A-21.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-21.

Govalle Wastewater Treatment Plant.

This alternative would require abandonment of the activated sludge units and replacement with lime clarification facilities, in addition to the other necessary units required for this method of treatment. Again, the design capacity is assumed to be 26 mgd. Costs for the improvements to this facility are shown in Table A-21.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which

time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of the proposed facilities at the Williamson Creek and Onion Creek Wastewater Treatment Plants is presented in Table A-21

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-21

ALTERNATIVE B-3
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Physical-Chemical Facilities (18 mgd)	$ 8,000,000	$1,708,200
1975	Engineering and Contingencies	1,288,000	
	Total	$ 9,288,000	$1,708,200
1983	Expand Physical-Chemical Facilities (10 mgd)	$ 5,200,000	2,452,800
1983	Engineering and Contingencies	852,800	
	Total	$ 6,052,800	$ 2,452,800
1998	Expand Physical-Chemical Facilities (10 mgd)	$ 5,200,000	$ 3,190,100
1998	Engineering and Contingencies	852,800	
	Total	$ 6,052,800	$3,190,100

2010	Expand Physical-Chemical Facilities (10 mgd)	$ 5,200,000	$3,854,400
2010	Engineering and Contingencies	852,800	
	Total	$ 6,052,800	$3,854,400
	GOVALLE TREATMENT PLANT		
1975	Upgrade Existing Unit to Highest Level of Physical-Chemical Treatment	$ 11,000,000	$2,372,500
1975	Engineering and Contingencies	1,760,000	
	Total	$ 12,760,000	$2,372,500
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT		
1980	Construct Highest Level Physical-Chemical Facility (8 mgd)	$ 4,400,000	$ 934,400
1980	Engineering and Contingencies	726,000	
	Total	$ 5,126,000	$ 934,400
1994	Expand Physical-Chemical Facilities (6 mgd)	$ 3,600,000	$1,379,700
1994	Engineering and Contingencies	597,600	
	Total	$ 4,197,600	$1,379,700
2009	Expand Physical-Chemical Facilities (6 mgd)	$ 3,600,000	$1,861,500
2009	Engineering and Contingencies	597,600	
	Total	$ 4,197,600	$1,861,500

Alternative B-4A.

Under this alternative, the feasibility of operating one regional plant to meet the highest level of treatment objective is presented. This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all sewage at one central or regional sewage treatment plant at Onion Creek. The method of treatment proposed is the biological activated sludge process, and includes nitrification, denitrification, filtration, activated carbon treatment, chlorination and aeration. The facilities along with estimates of cost are summarized in

Table A-22. As in the case of the discussion of previous regionalization alternative (Alternative A-2), intercepting sewers would have to be constructed from the Walnut Creek and Govalle sewage treatment plants to the proposed Onion Creek site, and total cost estimates must reflect this added expense. (Total Capital: $17,036,000; Annual O&M $469,200.)

The same sizing and phasing proposed under Alternative A-2 will also be assumed here: construct the initial 40.0 mgd plant by 1975; construct a 25.0 mgd expansion in 1988; and construct a 25.0 mgd expansion in 2005.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system costs detailed on Table A-11 are summarized below:

Collection System Cost Summary

Items	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-22

ALTERNATIVE B-4A
COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Biological Treatment Facilities (40 mgd) to Meet Highest Level of Treatment Objective	$23,000,000	$3,066,000
1975	Engineering and Contingencies	3,634,000	
	Total	$26,634,000	$3,066,000
1988	Expand Biological Facilities (25 mgd)	$16,000,000	$4,745,000
1988	Engineering and Contingencies	2,544,000	
	Total	$18,544,000	$4,745,000

2005	Expand Biological Facilities (25 mgd)	$16,000,000	$6,241,500
2005	Engineering and Contingencies	2,544,000	
	Total	$18,544,000	$6,241,500

Alternative B-4B.

Under this alternative, the feasibility of operating one regional plant to meet the highest level of treatment objective is presented. This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all the sewage at one central or regional new wastewater treatment facility at Onion Creek. The method of treatment proposed is a biological (trickling filter) process, and includes nitrification (using trickling filter), denitrification, filtration, activated carbon treatment, chlorination, and aeration. The facilities proposed along with estimates of cost are summarized in Table A-23. As in the case of the discussion of previous regional alternatives, intercepting sewers would have to be constructed from the Walnut Creek and Govalle sewage treatment plants to the proposed Onion Creek site, and total cost estimates must reflect this added expense (Total Capital: $17,036,000; Annual O&M: $469,200).

The same sizing and phasing proposed under Alternative A-2 will also be assumed here: construct the initial 40.0 mgd plant by 1975; construct a 25.0 mgd expansion in 1988; and construct a 25.0 mgd expansion in 2005.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-23

ALTERNATIVE B-4B
COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Biological Treatment Facilities (40 mgd) to meet Highest Level of Treatment Objective	$34,000 000	$2,190,000
1975	Engineering and Contingencies	5,338,000	
	Total	$39,338,000	$2,190,000
1988	Expand Biological Facilities (25 mgd)	$22,000,000	$3,321,500
1988	Engineering and Contingencies	3,476,000	
	Total	$25,476,000	$3,321,500
2005	Expand Biological Facilities (25 mgd)	$22,000,000	$6,077,250
2005	Engineering and Contingencies	3,476,000	
	Total	$25,476,000	$6,077,250

Alternative B-4C.

Under this alternative, the feasibility of operating one regional plant to meet the highest level of treatment objective is presented. This plant proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all sewage at one central or regional sewage treatment plant at Onion Creek. The method of treatment proposed is a physical-chemical process which includes high lime treatment, neutralization with carbon dioxide, ammonia stripping, denitrification, activated carbon treatment, chlorination and aeration. The facilities proposed along with estimates of cost are summarized in Table A-24. As in the case of the discussion of previous regionalization alternatives, intercepting sewers would have to be constructed from the Walnut Creek and Govalle sewage treatment plants to the proposed Onion Creek site, and total cost estimates must reflect this added expense (Total Capital: $17,036,000; Annual O&M: $469,200).

The same sizing and phasing proposed under Alternative A-2 will also be assumed here: construct the initial 40.0 mgd plant by 1975; construct a 25.0 mgd expansion in 1988; and construct a 25.0 mgd expansion in 2005.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience,

the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-24

ALTERNATIVE B-4C
COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Physical-Chemical Treatment Facilities (40 mgd) to meet Highest Level of Treatment Objective	$15,000,000	$3,358,000
1975	Engineering and Contingencies	2,385,000	
	Total	$17,385,000	$3,358,000
1988	Expand Physical-Chemical Facilities (25 mgd)	$10,000,000	$5,219,500
1988	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$5,219,500
2005	Expand Physical-Chemical Facilities (25 mgd)	$10,000,000	$6,898,500
2005	Engineering and Contingencies	1,600,000	
	Total	$11,600,000	$6,898,500

Alternative B-5.

This plan proposes: (a) activated sludge secondary treatment at the existing Walnut Creek Wastewater Treatment Plant; (b) operation of the existing Govalle Wastewater Treatment Plant; (c) construction of a new activated sludge secondary treatment plant at Onion Creek; (d) increasing the treatment capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e)

treating all effluent from those secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility. The facilities proposed along with estimates of costs are summarized in Table A-25.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-25.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek plants combined.

The existing capacity of the Govalle Plant is reported to be 40 mgd. For operation and maintenance cost estimates of secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of the proposed facilities at the Williamson Creek Wastewater Treatment Plant is also presented in Table A-25.

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between Williamson Creek plant and the Colorado River. The projected populations of these areas are given below:

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek		2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements is presented in Table A-25.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

	Years		
Item	1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-25

ALTERNATIVE B-5
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Secondary Facilities (18 mgd)	$4,800,000	$ 427,000
1975	Engineering and Contingencies	787,200	
	Total	$5,587,200	$ 427,000
1983	Expand Biological Facilities (10 mgd)	$3,000,000	$ 664,300
1983	Engineering and Contingencies	489,000	
	Total	$3,489,000	$ 664,300
1998	Expand Biological Facilities (10 mgd)	$3,000,000	$ 832,200
1998	Engineering and Contingencies	489,000	
	Total	$3,489,000	$ 832,200
2010	Expand Biological Facilities (10 mgd)	$3,000,000	$1,051,200
2010	Engineering and Contingencies	489,000	
	Total	$3,489,000	$1,051,200
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT PLANT		
1980	Construct Biological Secondary Facility (8 mgd)	$2,600,000	$ 219,000
1980	Engineering and Contingencies	434,200	
	Total	$3,034,200	$ 219,000
1994	Expand Biological Facilities (6 mgd)	$2,000,000	$ 347,500
1994	Engineering and Contingencies	338,000	
	Total	$2,338,000	$ 347,500

2009	Expand Biological Facilities (6 mgd)	$2,000,000	$ 474,500
2009	Engineering and Contingencies	338,000	
	Total	$2,338,000	$ 474,500

Proposed Spray Irrigation Tertiary Treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County to locate suitable soil types for the three methods of land disposal.

Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal tertiary treatment. Instead, the proposed Onion Creek plant was considered.

A detailed discussion of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment system, by phases, are presented in Table A-26.

TABLE A-26

ALTERNATIVE B-5
IRRIGATION COST SUMMARY

Year	Construction Item	Capital Cost	Annual O&M Cost
1975	Construct Spray Field System (43 mgd)	$ 2,297,700	$ 400,000
1975	Construct Holding Facility (80 acre)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek & Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facility to Spray Field)	4,449,000	520,000
1975	Engineering and Contingencies	1,863,700	
1975	Land Acquisition (2,840 ac. at $1,000/ac.)	2,895,700	
	Total	$16,407,600	$1,494,000

1980	Construct Pumping System for Onion Creek Plant	$ 624,000	$ 67,300
1980	Engineering and Contingencies	115,400	
1980	Annual Cost:		
	Spray Field		400,000
	Holding Facilities		250,000
	Pumping Facilities (Treatment Plants)		324,000
	Pumping Facilities (Holding Facilities)		520,000
	Total	$ 739,400	$1,561,300
1990	Expand Spray Field System (14 mgd)	$ 765,900	$ 523,300
1990	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	1,018,500	744,000
1990	Engineering and Contingencies	318,600	
1990	Land Acquisition (1,000 ac. at $1,000/ac.)	1,019,600	
1990	Annual Costs (Holding Facilities)		250,000
	Total	$ 3,212,600	$1,938,300
2000	Expand Spray Field System (16.5 mgd)	$ 1,798,200	$ 830,500
2000	Pumping Facilities (Walnut Creek, Govalle & Onion Creek Plant)	293,000	680,000
2000	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	2,623,000	816,000
2000	Engineering and Contingencies	773,100	
2000	Land Acquisition	2,039,200	
2000	Annual Costs (Holding Facilities) (2,000 ac. at $1,000/ac.)		250,000
	Total	$ 7,526,500	$2,576,500

Alternative B-6.

This plant proposes: (a) increasing the capacity of the activated sludge secondary treatment facilities at the existing Walnut Creek Wastewater Treatment Plant; (b) operation of the existing Govalle Wastewater Treatment Plant; (c) construction of new activated sludge secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal

facility. The facilities proposed along with estimates of costs are summarized in Table A-27.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-27.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek plants combined.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of the proposed facilities at the Williamson Creek Wastewater Treatment Plant is also presented in Table A-27.

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this

proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as the proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The projected populations of these areas are given below:

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek	___	2,500	5,000	11,500	26,000	58,500
Total	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adquate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements are also presented in Table A-27.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	793,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-27

ALTERNATIVE B-6
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Facilities (18 mgd)	$4,800,000	$ 427,000
1975	Engineering and Contingencies	787,200	
	Total	$5,587,200	$ 427,000
1983	Expand Biological Facilities (10 mgd)	$3,000,000	$ 664,300
1983	Engineering and Contingencies	489,000	
	Total	$3,489,000	$ 664,300
1998	Expand Biological Facilities (10 mgd)	$3,000,000	$ 832,200
1998	Engineering and Contingencies	489,000	
	Total	$3,489,000	$ 832,200
2010	Expand Biological Facilities (10 mgd)	$3,000,000	$1,051,200
2010	Engineering and Contingencies	489,000	
	Total	$3,489,000	$1,051,200
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT PLANT		
1980	Construct Biological Secondary Facility (8 mgd)	$2,600,000	$ 219,000
1980	Engineering and Contingencies	434,200	
	Total	$3,034,200	$ 219,000
1994	Expand Biological Facilities (6 mgd)	$2,000,000	$ 347,500
1994	Engineering and Contingencies	338,000	
	Total	$2,338,000	$ 347,500

2009	Expand Biological Facilities (6 mgd)	$2,000,000	$ 474,500
2009	Engineering and Contingencies	338,000	
	Total	$2,338,000	$ 474,500

Proposed Overland Runoff Tertiary Treatment

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County in locating suitable soil types for the three methods of land disposal. Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal tertiary treatment. Instead, the proposed Onion Creek plant was considered.

A detailed discussion of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment system, by phases, are presented in Table A-28.

TABLE A-28

ALTERNATIVE B-6
IRRIGATION COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Spray Field System (43 mgd)	$ 5,960,700	$1,018,200
1975	Construct Holding Facility (80 acres)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek and Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	10,036,600	520,000
1975	Land Acquisition (7,400 ac. @ $500/ac.)	3,772,500	
1975	Engineering and Contingencies	3,302,000	
	Total	$38,529,900	$2,112,200
1980	Construct Pumping System for Onion Creek Plant	$ 624,000	67,300
1980	Engineering and Contingencies	115,400	
1980	Annual Costs		
	Spray Field		1,018,240
	Holding Facilities		250,000
	Pumping Facilities (Treatment Plants)		324,000
	Pumping Facilities (Spray Field)		520,000
	Total	$ 739,400	$2,179,500

1990	Expand Spray Field System (14 mgd)	$ 1,931,400	$1,348,170
1990	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	5,068,500	744,000
1990	Engineering and Contingencies	1,148,500	
1990	Land Acquisition (3,000 ac. @ $500/ac.)	1,529,400	
1990	Annual Costs (Holding Facilities)		250,000
	Total	$ 9,767,800	$2,763,170
2000	Expand Spray Field System (34.3 mgd)	$ 4,761,900	$2,161,600
2000	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	293,000	680,000
2000	Pumping and Transmission Facilities	4,429,000	816,000
2000	Engineering and Contingencies	1,527,000	
2000	Land Acquisition (4,800 ac. @ $500/ac.)	2,447,100	
2000	Annual Costs (Holding Facilities)		250,000
	Total	$ 13,488,000	$3,907,600

Alternative B-7.

This plan proposes: (a) changing the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a trickling filter secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new trickling filter secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility. The facilities proposed along with estimates of cost are summarized in Table A-29.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-29.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek plants combined.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of these proposed facilities at the Williamson Creek Wastewater Treatment Plant are presented in Table A-29

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek Plant and the Colorado River. The projected population of these areas are given below:

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek		2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements are also presented in Table A-29.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-29

ALTERNATIVE B-7
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Facilities (18 mgd)	$12,700,000	$ 354,780
1975	Engineering and Contingencies	2,032,000	
	Total	$14,732,000	$ 354,780
1983	Expand Biological Facilities (10 mgd)	$ 7,300,000	$ 511,000
1983	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$ 511,000
1998	Expand Biological Facilities (10 mgd)	$ 7,300,000	$ 665,760
1998	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$ 665,760
2010	Expand Biological Facilities (10 mgd)	$ 7,300,000	$ 823,440
2010	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$ 823,440
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT PLANT		
1980	Construct Biological Secondary (8 mgd)	$ 6,000,000	$ 189,800
1980	Engineering and Contingencies	975,000	
	Total	$ 6,975,000	$ 189,800
1994	Expand Biological Facilities	$ 4,500,000	$ 296,380
1994	Engineering and Contingencies	738,000	
	Total	$ 5,238,000	$ 296,380

2009	Expand Biological Facilities	$4,500,000	$ 386,900
2009	Engineering and Contingencies	738,000	
	Total	$5,238,000	$ 386,900

Proposed Spray Irrigation Tertiary Treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County in locating suitable soil types for the three methods of land disposal. Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal tertiary treatment. Instead, the proposed Onion Creek plant was considered.

A detailed discussion of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment, by phases, are presented in Table A-30.

TABLE A-30

ALTERNATIVE B-7
IRRIGATION COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Constuct Spray Field System (43 mgd)	$ 2,297,700	$ 400,000
1975	Construct Holding Facility (80 acres)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek and Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	4,449,000	520,000
1975	Engineering and Contingencies	1,863,700	
1975	Land Acquisition (7,400 acres @ $500/ac.)	2,895,700	
	Total	$ 16,407,600	$1,494,000
1980	Construct Pumping System for Onion Creek Plant	$ 624,000	$ 67,300
1980	Engineering and Contingencies	115,400	
1980	Annual Costs		
	Spray Field		400,000
	Holding Facilities		250,000
	Pumping Facilities (Plants to Holding Facilities)		324,000
	Pumping Facilities (Holding Facilities to Spray Field)		520,000
		$ 739,400	$1,561,300

1990	Expand Spray Field System (14 mgd)	$ 765,900	$ 523,300
1990	Pumping Facilities (Walnut Creek, Govalle & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	1,018,500	744,000
1990	Engineering and Contingencies	318,600	
1990	Land Acquisition (3,000 ac. @ $500/ac.)	1,019,600	
1990	Annual Costs (Holding Facilities)		250,000
	Total	$ 3,212,600	$1,938,300
2000	Expand Spray Field System (16.5 mgd)	$ 1,798,200	$ 830,500
2000	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek)	293,000	680,000
2000	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	2,623,000	816,000
2000	Engineering and Contingencies	773,100	
2000	Land Acquisition (4,800 ac. @ $500/ac.)	2,039,200	
2000	Annual Costs (Holding Facilities)		250,000
	Total	$7,526,500	$2,576,500

Alternative B-8.

This plan proposes: (a) converting the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a trickling filter secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new trickling filter secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal facility. The facilities proposed along with estimates of cost are summarized in Table A-31.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-31.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek plants combined.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of these proposed facilities at the Williamson Creek Wastewater Treatment Plant are presented in Table A-31.

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confuence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. The proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The projected populations of these areas are given below:

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek	———	2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements are also presented in Table A-31.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-31

ALTERNATIVE B-8
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Biological Facilities (18 mgd)	$12,700,000	$354,780
1975	Engineering and Contingencies	2,032,000	
	Total	$14,732,000	$354,780

1983	Expand Biological Facilities (10 mgd)	$ 7,300,000	$511,000
1983	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$511,000
1998	Expand Biological Facilities (10 mgd)	$ 7,300,000	$665,760
1998	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$665,760
2010	Expand Biological Facilities (10 mgd)	$ 7,300,000	$823,440
2010	Engineering and Contingencies	1,179,000	
	Total	$ 8,479,000	$823,440

WILLIAMSON CREEK TREATMENT PLANT

1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$140,000

PROPOSED ONION CREEK TREATMENT PLANT

1980	Construct Biological Secondary Facility (8 mgd)	$ 6,000,000	$189,800
1980	Engineering and Contingencies	975,000	
	Total	$ 6,975,000	$189,800
1994	Expand Biological Facilities	$ 4,500,000	$296,380
1994	Engineering and Contingencies	738,000	
	Total	$ 5,238,000	$296,380
2009	Expand Biological Facilities	$ 4,500,000	$386,900
2009	Engineering and Contingencies	738,000	
	Total	$ 5,238,000	$386,900

Proposed Overland Runoff Tertiary Treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County in locating suitable soil types for the three methods of land disposal. Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal tertiary treatment. Instead, the proposed Onion Creek plant was considered. A detailed discussion

of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment system, by phases, are presented in Table A-32.

TABLE A-32

ALTERNATIVE B-8
IRRIGATION COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Spray Field System (43 mgd)	$ 5,960,700	$1,018,200
1975	Construct Holding Facility (80 acres)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek and Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	10,036,600	520,000
1975	Engineering and Contingencies	3,302,000	
1975	Land Acquisition (7,400 ac. @ $500/ac.)	3,772,500	
	Total	$38,529,900	$2,112,200
1980	Construct Pumping System for Onion Creek Plant	$ 624,000	$ 67,300
1980	Engineering and Contingencies	115,400	
1980	Annual Costs		
	Spray Field		1,018,240
	Holding Facilities		250,000
	Pumping Facilities (Plants to Holding Facilities)		324,000
	Pumping Facilities (Holding Facilities to Spray Field)		520,000
	Total	$ 739,400	$2,179,500
1990	Expand Spray Field System (14 mgd)	$ 1,931,400	$1,348,170
1990	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	5,068,500	744,000
1990	Engineering and Contingencies	1,148,500	
1990	Land Acquisition (3,000 ac. @ $500/ac.)	1,529,400	
1990	Annual Cost (Holding Facilities)		250,000
	Total	$ 9,767,800	$2,763,170

2000	Expand Spray Field System (34.3 mgd)	$ 4,761,900	$ 2,161,600
2000	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	293,000	680,000
2000	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	4,429,000	816,000
2000	Engineering and Contingencies	1,527,000	
2000	Land Acquisition (4,800 ac. @ $500/ac.)	2,447,100	
2000	Annual Costs (Holding Facilities)		250,000
	Total	$13,488,000	$ 3,907,600

Alternative B-9.

This plan proposes: (a) converting the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a physical-chemical secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constucting new physical-chemical secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and further treating all the effluent from these secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility. The facilities proposed along with estimates of cost are summarized in Table A-33.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-33.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek plants combined.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26. mgd which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek Plant and the Colorado River. The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimates of the costs of these proposed facilties at the Williamson Creek Wastewater Treatment Plant are presented in Table A-33.

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek Plant and the Colorado River. The projected populations of these areas are given below:

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population Below Williamson Creek Plant along Onion Creek	———	2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements are also presented in Table A-33.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system improvement costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-33

ALTERNATIVE B-9
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Physical-Chemical Facilities (18 mgd)	$2,800,000	$ 768,700
1975	Engineering and Contingencies	469,000	
	Total	$3,269,000	$ 768,700
1983	Expand Physical-Chemical Facilities (10 mgd)	$1,700,000	$1,124,200
1983	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,124,200
1998	Expand Physical-Chemical Facilities (10 mgd)	$1,700,000	$1,498,000
1998	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,498,000
2010	Expand Physical-Chemical Facilities (10 mgd)	$1,700,000	$1,839,600
2010	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,839,600

WILLIAMSON CREEK TREATMENT PLANT

1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000

PROPOSED ONION CREEK TREATMENT PLANT

1980	Construct Physical-Chemical Secondary Facility (8 mgd)	$1,450,000	$ 379,600
1980	Engineering and Contingencies	254,500	
	Total	$1,704,500	$ 379,600
1994	Expand Physical-Chemical Facilities (6 mgd)	$1,330,000	$ 613,200
1994	Engineering and Contingencies	233,500	
	Total	$1,563,500	$ 613,200
2009	Expand Physical-Chemical Facilities (6 mgd)	$1,330,000	$ 832,200
2009	Engineering and Contingencies	233,500	
	Total	$1,563,500	$ 832,200

Proposed Spray Irrigation Tertiary Treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County to locate suitable soil types for the three methods of land disposal. Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal teritary treatment. Instead, the proposed Onion Creek plant was considered.

A detailed discussion of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment facilities, by phases, are presented in Table A-34.

TABLE A-34

ALTERNATIVE B-9
IRRIGATION COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Spray Field System (43 mgd)	$2,297,700	$ 400,000
1975	Construct Holding Facility (80 acres)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek and Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	4,449,000	520,000
1975	Land Acquisition (7,400 ac. @ $500/ac.)	2,895,700	
1975	Engineering and Contingencies	1,863,700	
	Total	$16,407,600	$1,494,000
1980	Construct Pumping System for Onion Creek Plant	$ 624,000	$ 67,300
1980	Engineering and Contingencies	115,400	
1980	Annual Costs		
	Spray Field		400,000
	Holding Facilities		250,000
	Pumping Facilities (Plants to Holding Facilities)		324,000
	Pumping Facilities (Holding Facilities to Spray Field)		520,000
	Total	$ 739,400	$1,561,300
1990	Expand Spray Field System (14 mgd)	$ 765,900	$ 523,300
1990	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Fields)	1,018,500	744,000
1990	Engineering and Contingencies	318,600	
1990	Land Acquisition (3,000 ac. @ $500/ac.)	1,019,600	
1990	Annual Cost (Holding Facilities)		250,000
	Total	$3,212,600	$ 1,938,300

2000	Expand Spray Field System (16.5 mgd)	$1,798,200	$ 830,500
2000	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	293,000	680,000
2000	Pumping and transmission Facilities (Holding Facilities to Spray Field)	2,623,000	816,000
2000	Engineering and Contingencies	773,100	
2000	Land Acquisition (4,800 ac. @ $500/ac.)	2,039,200	
2000	Annual Costs (Holding Facilities)		250,000
	Total	$7,526,500	$2,576,500

Alternative B-10.

This plan proposes: (a) modifying the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a physical-chemical secondary treatment facilities and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new physical-chemical secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal facility. The facilities proposed along with estimates of cost are summarized in Table A-35.

Walnut Creek Wastewater Treatment Plant.

This facility would be constructed and expanded in several increments as needed. The specific proposals are contained in Table A-35.

Govalle Wastewater Treatment Plant.

The Govalle plant should not require any expansion to its secondary treatment facilities during the study period. As mentioned before, the expansion of the Walnut Creek plant will reduce the existing and proposed load on the Govalle plant, as indicated by the population projections below:

	1970	1980	1990	2000	2010	2020
Population	140,300*	117,031	142,426	173,565	204,110	228,937
Required Plant Capacity, mgd	14.0	11.7	14.2	17.4	20.4	22.9

*Estimated population served by Govalle and Williamson Creek Plants combined.

The existing capacity of the Govalle plant is reported to be 40 mgd. For operation and maintenance cost estimates for secondary treatment over the study period (1975-2020), it will be assumed that the plant will average 26 mgd, which is the present average flow.

Williamson Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and to construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River.

The existing rated capacity of the Williamson Creek plant is 3.0 mgd; therefore, an expansion of the facilities to approximately 4.5 mgd will be required at present to serve until 1980, at which time it is proposed to construct the Onion Creek plant. The Williamson Creek plant will not require tertiary treatment facilities. Estimate of the costs of these proposed facilities at the Williamson Creek Wastewater Treatment Plant are presented in Table A-35.

Proposed Onion Creek Wastewater Treatment Plant.

The City of Austin plans to abandon the existing Williamson Creek sewage treatment plant and construct a new facility farther downstream on Onion Creek at its confluence with the Colorado River. (See Plate A-2, Plant D.) At the present time, the City does not plan to construct this proposed plant until about 1980. This proposed plant, which will be referred to as the Onion Creek Wastewater Treatment Plant, will serve the existing and proposed development tributary to the Williamson Creek plant as well as proposed development along Onion Creek between the Williamson Creek plant and the Colorado River. The projected populations of these areas are given below

	1970	1980	1990	2000	2010	2020
Population Tributary to Williamson Creek Plant	13,100*	42,939	63,139	89,960	119,162	139,426
Population below Williamson Creek Plant along Onion Creek		2,500	5,000	11,500	26,000	58,500
Totals	13,100	45,439	68,139	101,460	145,162	197,926

*Estimated

The population projections indicate that the Onion Creek plant will require a capacity of approximately 4.5 mgd in 1980 and 20.0 mgd by 2020. It is recommended that the first increment of secondary treatment constructed in 1980 have a capacity of 8.0 mgd, which would be adequate until 1994. In 1994, an expansion of 6.0 mgd would be adequate until 2009, at which time a

second 6.0 mgd expansion is proposed to serve until 2020. The estimated costs and phasing of these proposed improvements are also shown in Table A-35.

Collection System Cost Summary.

As mentioned in the introduction to this alternative discussion, the capital and annual O&M costs associated with the basic collection system improvements for all alternatives will be the same. For convenience, the collection system costs detailed in Table A-11 are summarized below:

Collection System Cost Summary

Item	Years 1980	1990	2020
Total Capital Costs*	$46,040,100	$664,300	$1,512,500
Total Annual O&M Costs	796,600	807,700	833,500

*Including Engineering and Contingencies

TABLE A-35

ALTERNATIVE B-10
SUMMARY COSTS

Year	Proposed Improvement	Capital Cost	Annual O&M Cost
	WALNUT CREEK TREATMENT PLANT		
1975	Construct Physical-Chemical Facilities (18 mgd)	$2,800,000	$ 768,700
1975	Engineering and Contingencies	469,000	
	Total	$3,269,000	$ 768,700
1983	Expand Physical-Chemical Facilities (10 mgd)	$1,700,000	$1,124,200
1983	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,124,200
1998	Expand Physical-Chemical Facilites (10 mgd)	$1,700,000	$1,498,000
1998	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,498,000

2010	Expand Physical-Chemical Facilities (10 mgd)	$1,700,000	$1,839,600
2010	Engineering and Contingencies	293,300	
	Total	$1,993,300	$1,839,600
	WILLIAMSON CREEK TREATMENT PLANT		
1975	Expand Secondary Facilities to 4.5 mgd	$ 100,000	$ 140,000
1975	Engineering and Contingencies	21,600	
	Total	$ 121,600	$ 140,000
	PROPOSED ONION CREEK TREATMENT PLANT		
1980	Construct Highest Level Physical-Chemical Facility (8 mgd)	$1,450,000	$ 379,600
1980	Engineering and Contingencies	254,500	
	Total	$1,704,500	$ 379,600
1994	Expand Physical-Chemical Facilities (6 mgd)	$1,330,000	$ 613,200
1994	Engineering and Contingencies	233,500	
	Total	$1,563,500	$ 613,200
2009	Expand Physical-Chemical Facilities (6 mgd)	$1,330,000	$ 832,200
2009	Engineering and Continencies	233,500	
	Total	$1,563,500	$ 832,200

Proposed Overland Runoff Tertiary Treatment.

Since the Walnut Creek, Govalle, and proposed Onion Creek sewage treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all three plants, rather than three separate operations. This decision was also reached after studying the general soil maps of Travis County in locating suitable soil types for the three methods of land disposal.

Since the Williamson Creek plant is proposed to be abandoned by 1980, it was not considered in the discussion of land disposal tertiary treatment. Instead, the proposed Onion Creek plant was considered. A detailed discussion of the land disposal method of tertiary treatment is presented in Appendix D of this section. The estimated costs of the proposed land disposal tertiary treatment, by phases, are presented in Table A-36.

TABLE A-36

ALTERNATIVE B-10
IRRIGATION COST SUMMARY

Year	Cost Item	Capital Cost	Annual O&M Cost
1975	Construct Spray Field System (43 mgd)	$ 5,960,700	$ 1,018,200
1975	Construct Holding Facility (80 acre)	1,928,500	250,000
1975	Pumping and Transmission Facilities (Walnut Creek and Govalle Plants)	2,973,000	324,000
1975	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	10,036,600	520,000
1975	Land Acquisition (7,400 ac. @ $500/ac.)	3,772,500	
1975	Engineering and contingencies	3,302,000	
	Total	$ 27,973,300	$ 2,112,200
1980	Construct Pumping System for Onion Creek Plant	$ 624,000	$ 67,300
1980	*Engineering and Contingencies*	115,400	
1980	Annual Costs		
	Spray Field		1,018,240
	Holding Facilities (Plants to Holding Facilities)		250,000
	Pumping Facilities (Holding Facilities to Spray Field)		324,000
	Pumping Facilities		520,000
	Total	$ 739,400	$ 2,179,500
1990	Expand Spray Field System (14 mgd)	$ 1,931,400	$ 1,348,170
1990	Pumping Facilities (Walnut Creek, Govalle, & Onion Creek Plants)	90,000	421,000
1990	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	5,068,500	744,000
1990	Engineering and Contingencies	1,148,500	
1990	Land Acquisition (3,000 ac. @ $500/ac.)	1,529,400	
1990	Annual Costs (Holding Facilities)		250,000
	Total	$ 9,767,800	$ 2,763,170
2000	Expand Spray Field System (34.3 mgd)	$ 4,761,900	$ 2,161,600
2000	Pumping Facilities (Walnut Creek, Govalle & Onion Creek Plants)	293,000	680,000
2000	Pumping and Transmission Facilities (Holding Facilities to Spray Field)	4,429,000	816,000
2000	Engineering and contingencies	1,527,000	

2000	Land Acquisition (4,800 ac. @ $500/ac.)	2,447,100	
2000	Annual Costs (Holding Facilities)		250,000
	Total	$ 13,488,000	$ 3,907,600

Treatment Alternatives, Evaluation, Conclusions and Recommendations.

Evaluation of Alternatives.

For the Austin metropolitan area, a total of 14 alternative treatment schemes were investigated and developed during the conduct of this study. The impacts of all these alternatives were assessed and evaluated based on technical, economical, institutional, political, aesthetic, ecological, and social considerations. As a result, the following five alternatives; A-1, A-2, B-4A, B-4C, and B-5, were selected as the most viable, cost effective alternatives. All five alternatives were subjected to further detailed evaluation analysis. Results of that analysis are shown in Appendix B of this section. The aforementioned five alternatives were subsequently presented to representatives of the City of Austin for their consideration in the public workshop conducted at the Austin City Hall on 17 July 1973. Details of this public workshop meeting are shown in Volume II (Basin Plan Appendix), Appendix L. Alternative A-1 was selected by the participating Austin local interests as the most acceptable alternative considered.

The remaining nine alternatives investigated, but not selected for final presentation, meet a "highest level of treatment" objective which would place no limitations on the subsequent water use. These remaining highest level of treatment alternatives were studied for immediate (1975) implementation. Since the highest level of treatment objectives are stringent, these alternatives also meet the applicable effluent guidelines of PL 92-500, and are summarized below.

Alternative B-1.

This plan proposes: (a) upgrading the effluent quality and increasing the treatment capacity of the existing Walnut Creek Wastewater Treatment Plant; (b) upgrading the effluent quality of the existing Govalle Wastewater Treatment Plant; (c) constructing new wastewater treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment proposed is the biological treatment (activated sludge) process, and includes nitrification, denitrification, filtration, activated carbon treatment, chlorination and aeration.

This alternative was not selected for further refinement because it was not cost effective.

Alternative B-2.

This plan proposes: (a) upgrading the effluent quality and increasing the treatment capacity of the existing Walnut Creek Wastewater Treatment Plant; (b) upgrading the effluent quality of the existing Govalle Wastewater Treatment Plant; (c) constructing new wastewater treatment facilities at Onion Creek; and (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment proposed is a biological treatment (trickling filter) process, and includes nitrification (using trickling filter), denitrification, filtration activated carbon treatment, chlorination, and aeration.

This alternative was not selected for further refinement because it was not cost effective, and it would require extensive modification and replacement of the existing activated sludge plants.

Alternative B-3.

This plan proposes: (a) upgrading the effluent quality and treatment capacity of the existing Walnut Creek Wastewater Treatment Plant; (b) upgrading the effluent quality of the existing Govalle Wastewater Treatment Plant; (c) constructing new wastewater treatment facilities at Onion Creek; and (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of treatment is a physical-chemical treatment process, and includes high lime treatment, neutralization with cabon dioxide, ammonia stripping, denitrification, activated carbon treatment, chlorination and aeration.

This alternative was not selected for further refinement because it was not cost effective; it would require extensive modification and replacement of the existing activated sludge plants; it would require large quantities of non-renewable resources (chemicals); and it would present handling and disposal problems for the large volumes of chemical sludges generated.

Alternative B-4B.

This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all the sewage at one central or regional new wastewater treatment facility at Onion Creek. The method of treatment proposed is a biological (trickling filter) process, and includes nitrification (using trickling filter), denitrification, filtration, activated carbon treatment, chlorination, and aeration.

This alternative was not selected for further refinement because it was not cost effective; it is less efficient than the activated sludge process; and it is less flexible than the alternatives using the three wastewater treatment facilities.

Alternative B-6.

This plan proposes: (a) increasing the capacity of the activated sludge secondry treatment facilities at the existing Walnut Creek Wastewater Treatment Plant; (b) operation of the existing Govalle Wastewater Treatment Plant; (c) construction of new activated sludge secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal facility.

This alternative was not selected for further refinement because it was not acceptable to representatives of the City of Austin.

Alternative B-7.

This plan proposes: (a) changing the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a trickling filter secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new trickling filter secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility.

This alternative was not selected for further refinement because it was not acceptable to representatives of the City of Austin, and it would require extensive modification and replacement of the existing activated sludge plants.

Alternative B-8.

This plan proposes: (a) converting the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a trickling filter secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new trickling filter secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal facility.

This alternative was not selected for further refinement because it was not acceptable to representatives of the City of Austin; it would require extensive modification and replacement of the existing activated sludge plants, and it was not cost effective.

Alternative B-9.

This plan proposes: (a) converting the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a physical-chemical secondary treatment process and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new physical-chemical secondary treatment facilities at Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and further treating all the effluent from these secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility.

This alternative was not selected for further refinement because it was not acceptable to representatives of the City of Austin; it would require extensive modification and replacement of the existing activated sludge plants; it would require large quantities of non-renewable resources (chemicals); and it would present handling and disposal problems for the large volumes of chemical sludges generated.

Alternative B-10.

This plan proposes: (a) modifying the activated sludge facilities at the existing Walnut Creek Wastewater Treatment Plant to a physical-chemical secondary treatment facility and increasing its capacity; (b) maintaining the existing Govalle Wastewater Treatment Plant; (c) constructing new physical-chemical secondary treatment facilities a Onion Creek; (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from these secondary treatment plants by overland runoff tertiary treatment in one central land disposal facility.

This alternative was not selected for further refinement because it was not acceptable to representatives of the City of Austin; it would require extensive modification and replacement of the existing activated sludge plants; it would require large quantities of non-renewable resources (chemicals); and it would present handling and disposal problems for the large volumes of chemical sludges generated.

The five alternatives selected for further refinement and presented to the City of Austin for consideration, in the public workshop held on 17 July 1973, are summarized below.

Alternative A-1.

This alternative presents a plan for meeting the PL 92-500 by means of a phased implementation of wastewater treatment process as detailed in in Appendix A at the conclusion of the CAPCO section of this report. This

plan proposes: (a) upgrading the effluent quality and treatment capacity of the existing Walnut Creek Wastewater Treatment Plant; (b) upgrading the effluent quality of the existing Govalle Wastewater Treatment Plant; (c) constructing new wastewater treatment facilities at Onion Creek; and (d) increasing the capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980. The method of secondary treatment and tertiary treatment proposed is activated sludge, since all three Austin plants currently utilize this process.

Alternative A-2.

This alternative presents a plan for meeting the PL 92-500 by means of a phased implementation of wastewater treatment processes as detailed in Appendix A at the conclusion of the CAPCO section of this report. This plan proposes the abandonment of the existing Walnut Creek, Govalle and Williamson Creek Wastewater Treatment Plants, and treating all sewage at one central or regional sewage treatment plant located at Onion Creek. The proposed method of secondary and tertiary treatment is the activated sludge process.

Alternative B-4A.

This alternative presents a plan for meeting an immediate "highest level of treatment" objective which is defined in detail in the Technical Appendix (Volume III, Section III). This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all sewage at one central or regional sewage treatment plant located at Onion Creek. The method of treatment proposed is a biological (activated sludge) process, and includes nitrification, denitrification, filtration, activated carbon treatment, chlorination and aeration.

Alternative B-4C.

This alternative presents a plan for meeting an immediate "highest level of treatment" objective which is defined in detail in the Technical Appendix (Volume III, Section III). This plan proposes the abandonment of the existing Walnut Creek, Govalle, and Williamson Creek Wastewater Treatment Plants, and treating all sewage at one central or regional sewage treatment plant at Onion Creek. The method of treatment proposed is a physical-chemical process, and includes high lime treatment, neutralization with carbon dioxide, ammonia stripping, denitrification, activated carbon treatment, chlorination and aeration.

Alternative B-5.

This alternative presents a plan for meeting an immediate "highest level of treatment" objective which is defined in detail in the Technical Apppendix (Volume III, Section III). This plan proposes: (a) activated sludge secondary treatment at the existing Walnut Creek

Wastewater Treatment Plant; (b) operation of the existing Govalle Wastewater Treatment Plant; (c) construction of a new activated sludge secondary treatment plant at Onion Creek; (d) increasing the treatment capacity of the existing Williamson Creek Wastewater Treatment Plant and abandoning the plant when the Onion Creek Wastewater Treatment Plant is in operation by 1980; and (e) treating all the effluent from those secondary treatment plants by spray irrigation tertiary treatment in one central land disposal facility. Since the existing and proposed secondary treatment plants are located in the same general vicinity in the southeast part of Austin, land disposal was assumed to be at one central facility for all plants. This decision was also reached after studying the general soil maps of Travis County to locate suitable soil types for the three methods of land disposal and after analyzing the anticipated land use projections. The rapid infiltration method of land disposal was ruled out during the course of study, due to the lack of required soil information and the apparent short renovative distance and travel time available in those soil series found in Travis County.

Conclusion and Recommended Alternative.

Prior to conducting the public workshop, the five selected alternatives were sent to the City of Austin to give the City enough time for an in-depth study of the alternatives. For information purposes, a summary of the other nine alternatives investigated was also included in the data sent to the City of Austin. In the workshop held on 17 July 1973, Alternative A-1 was selected by the participating local interests of Austin. Reasons for rejecting the other four selected alternatives were not specifically discussed.

Alternative A-1 was selected as the best plan for Austin because it closely adhered to the format adopted by the City for its future programs; it meets the treatment requirements of PL 92-500; it is one of the most cost-effective alternatives; it takes full advantage of the existing wastewater treatment facilities and utilizes the expertise of the present operation and maintenance personnel associated with these existing wastewater treatment facilities; and during this public workshop, this plan was selected by participating local interests. It is therefore recommended that all steps necessary to implement Alternative A-1 plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance, and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly operated or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the 40 mgd

range would employ as many as one superintendent, four analysts, six operators, one maintenance man, and two laborers to provide around-the-clock attendance. Land disposal facilities for Austin would probably require another six to ten employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode is based on a daily sampling, testing and recording program. Typical tests and frequencies include:

1) Sludge measurements in settling tanks on each shift daily.

2) Settleable solids volume and pH measurements daily for influent and effluent.

3) Effluent stability tests on 24-hour composite samples.

4) Chlorine residual of effluent on each shift daily.

5) Total and volatile solids, volatile acids, and pH of digested sludge as needed.

6) BOD_5, TSS, and pH of influent and effluent daily on 24-hour composite sample.

7) Dissolved oxygen measurement on influent, effluent, and receiving stream above and below the discharge point five days per week.

8) For activated sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area near the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are drawn. Such monitoring is just one more means of maintaining the careful surveillance necessary to sound wastewater management.

In metropolitan areas like Austin, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to argument for responsible wastewater management; not just to meet government requirements, but also to protect the local environment.

In metropolitan areas like Austin, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management, not just to meet government requirements but also to protect the local environment.

APPENDIX A

Municipal Treatment Facilities
Operational Investigation
City of Austin, Texas

Preface.

During the course of the Wastewater Management Study, all municipal wastewater treatment facilities within the Basin were visited by members of the study staff. In addition, operational specialists were directed to visit those treatment facilities within the metropolitan areas and present their observations and findings in report form. The following text is a summary of that operational report.

General.

The City of Austin operates three wastewater treatment plants, the Govalle sewage treatment plant; and two smaller plants, Williamson Creek and Walnut Creek. Plate A-2 shows the location of the three treatment plants presently serving the City of Austin as well as the Crosstown Interceptor Tunnel which is currently under construction. This major sewer will divert wastewater from the Govalle treatment plant to the new Walnut Creek treatment plant. The Walnut Creek plant is due to be expanded to accept the increase in flow. The area served by the Interceptor Tunnel and the Walnut Creek treatment plant includes the most rapidly growing areas of the City. The estimated population in the Interceptor service area represented 36 percent of the City's population in 1960 and 44 percent in 1970.

In addition to the three sewage treatment plants, the City operates an oxidation pond facility at Hornsby Bend which receives waste sludge from the Govalle plant and a relatively small quantity of domestic waste from Bergstrom Air Force Base. Present treatment criteria have been established for the City of Austin by the Texas Water Quality Board (TWQB) which require average effluent quality not to exceed 20 mg/l BOD and 20 mg/l suspended solids with the quality of a composite sample not to exceed 25 mg/l BOD and 25 mg/l suspended solids.

Examination of existing treatment data indicates that the conventional activated sludge facilities under optimum operation can meet the 20/20 average effluent quality requirement, but often fall short of the 25/25 effluent quality of a composite sample criterion. Although there is no immediate evidence of water quality impairment in the Colorado River, it is expected that effluents will need to be treated to 12/9 quality in the near future to offset anticipated growth.

At present, there are no major reservoirs on the Colorado River downstream from Austin which can undergo quality changes due to nutrient

enrichment. In the event that a large reservoir is constructed, nutrient removal may be required.

Description of Existing Facilities.

Govalle Sewage Treatment Plant.

The Govalle sewage treatment plant is located in the southeastern part of Austin on Bolm Road near the Bluestein intersection. The waste treatment process is of the modified activated sludge type (contact-stabilization) with the effluent discharged directly into the Colorado River. The facilities are often used for research purposes by The University of Texas, the latest being a period from 1968 until 1970 which was a joint City of Austin-University of Texas project.

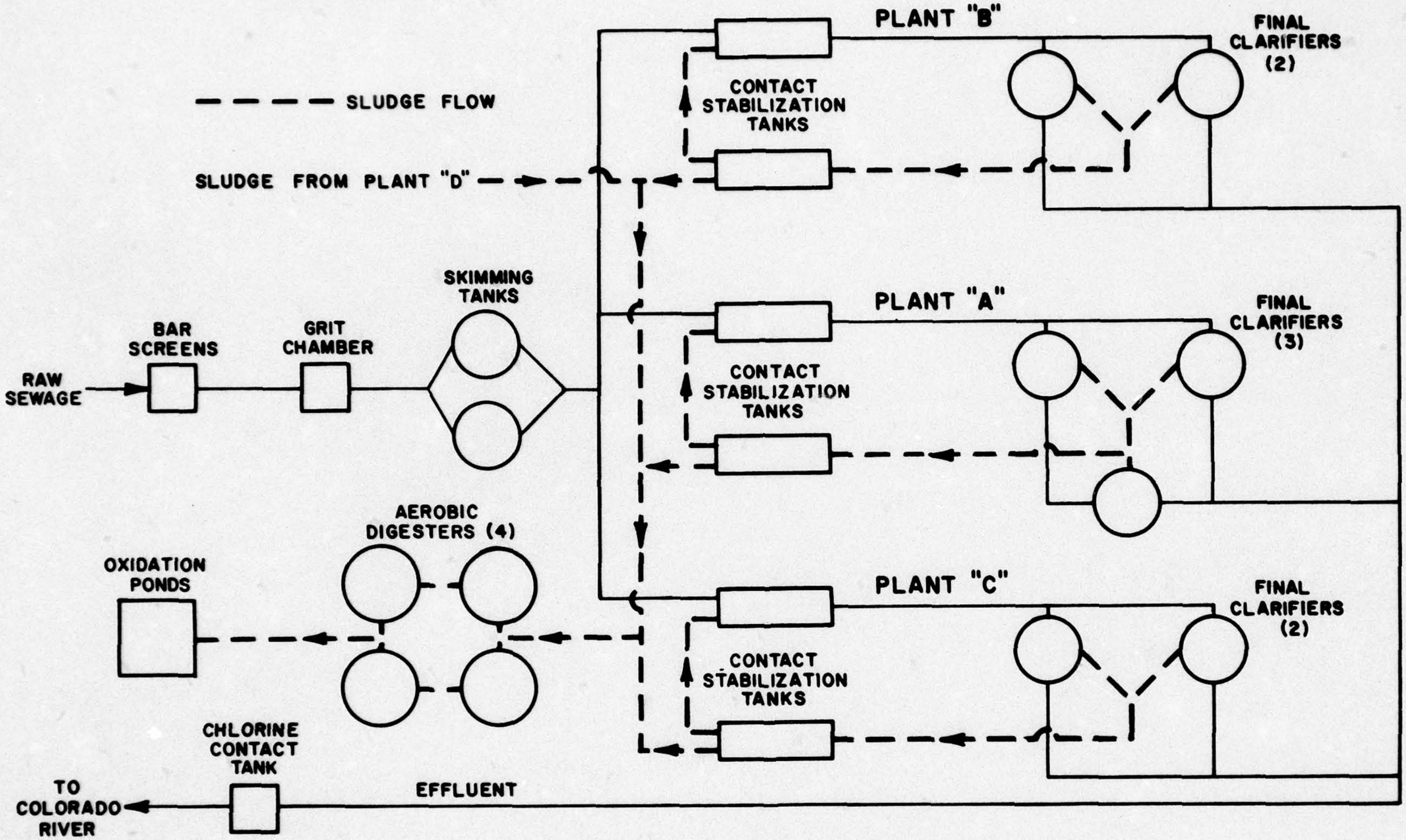
The domestic waste reaching the Govalle plant is combined with the effluents from several industries in the vicinity, a fact that has, at times, affected the treatment process. Other operational problems are mostly inherent in the design of the facility. Diagrams of the Govalle sewage treatment plant are shown in Figures 1-1 and 1-2.

The original activated sludge plant was sectioned into three parallel contact-stabilization units: Plant A, Plant B, and Plant C. The combined capacity of Plants A, B, and C is 30 mgd average dry weather flow with a 45 mgd maximum. Plant D has an average dry weather capacity of 10 mgd with a storm flow capacity of 125 mgd. The TWQB permitted discharge is 40 mgd with a 125 mgd maximum.

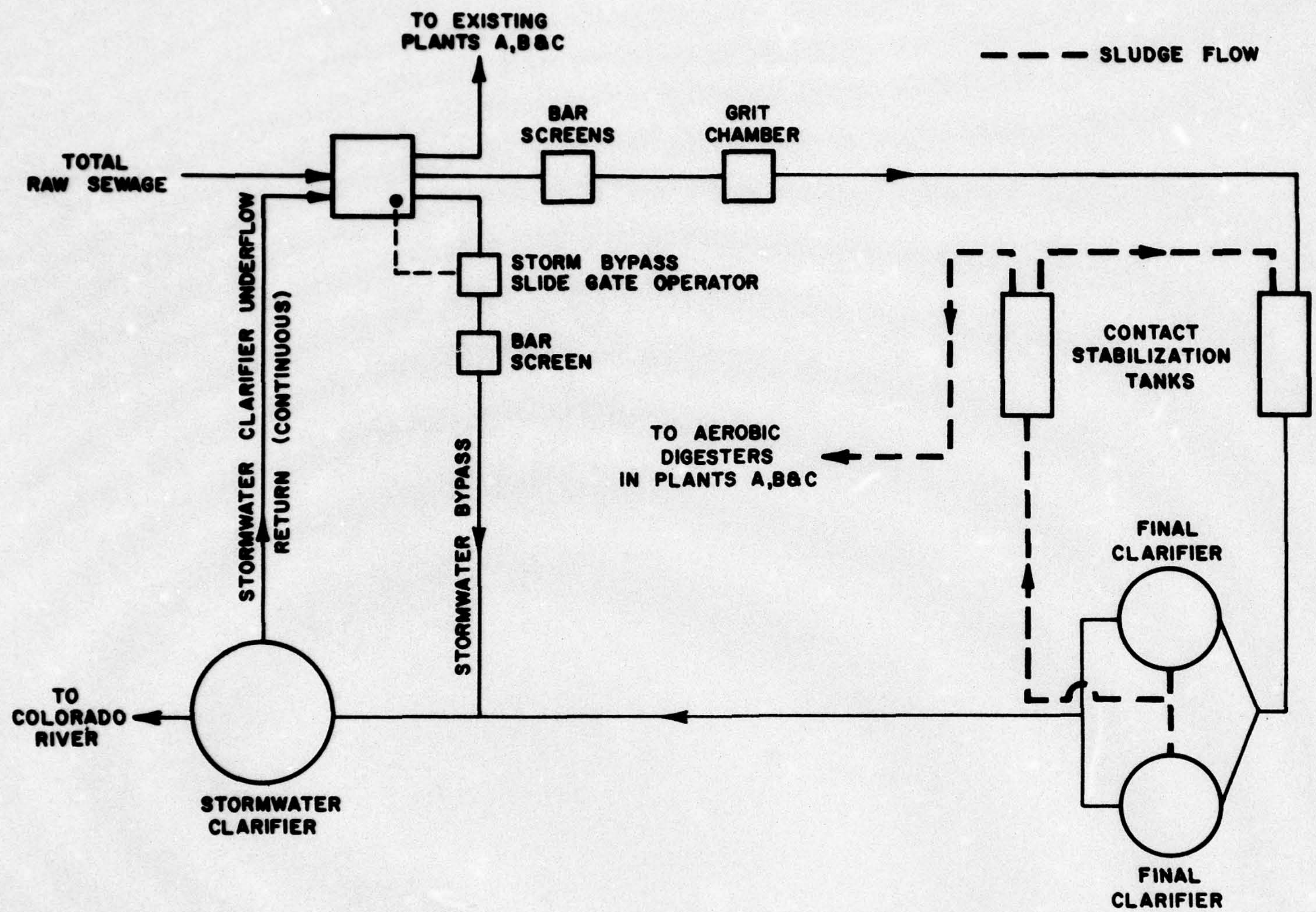
Sewage flow enters the plant and is split, with part of the flow going to Plants A, B, and C and part going to Plant D. The flow to Plants A, B, and C passes through three mechanically cleaned bar screens before entering the grit removal facility. The grit chamber is of the aerated, flow-through type. Grit is removed by two mechanical grit collectors and disposed of in a landfill. From the grit chamber, the sewage flows to two skimming tanks for grease removal. The skimmings are collected and disposed of with the grit from the grit chambers. Skimming tank underflow is returned to the main sewage flow. The flow is then split by means of slide gates and distributed to Plants A and B and to Plant C.

From the grit chamber, sewage proceeds through the contact-stabilization basins. Mixed liquor is conveyed to the final clarifiers while waste sludge is pumped to two aerobic digesters. Stabilized sludge is pumped to the Hornsby Bend oxidation ponds. The combined clarifier overflow proceeds to the chlorine contact basin before being discharged to the river.

All flow to the Govalle plant enters the entrance structure at "D" plant and 3/4 is directed to Plants A, B, and C; and 1/4 enters D Plant. Under storm conditions, the first 65 million gallons per day is directed through A, B, C, and D Plants and any excess diverted through a



FLOW DIAGRAM FOR PLANTS A,B&C
GOVALLE SEWAGE TREATMENT PLANT
FIGURE 1-1



PLANT "D"
FLOW DIAGRAM
GOVALLE SEWAGE TREATMENT PLANT
FIGURE 1-2

mechanical bar screen, heavily chlorinated and treated in the stormwater clarifier. The underflow from this clarifier is recycled through Plants A, B, C, and D. The sewage enters D Plant through two automatic mechanical bar screens and continues to an aerated, flow through type grit removal chamber. Sewage then proceeds to the aeration basin after being measured by a Parshall flume.

After aeration in the activated sludge basins, the mixed liquor flows by gravity to the two final clarifiers. Return sludge is pumped back to the aeration basin, while waste sludge is pumped to the aerobic digesters. Final clarifier overflow continues to the chlorination basin at the end of the stormwater bypass trough. The chlorination basin contains two chlorinators, one for normal flow and one for storm flow. Chlorinated effluent proceeds by gravity to the stormwater clarifier. Underflow from this stormwater clarifier is recirculated through this structure while the overflow is discharged into the river after chlorination. The two anaerobic digesters, presently not in use, are due to be converted to aerobic digesters in the near future.

Several operational problems exist in the plant; however, operating personnel seem well qualified. The plant has a well equipped laboratory with four full-time analysts. Monitoring analyses from all other plants are performed here.

The Williamson Creek Sewage Treatment Plant.

The Williamson Creek sewage treatment plant is located east of the City of Austin on Nuckels Crossing Road. The property extends to the confluence of Onion Creek and Williamson Creek. A schematic layout of the facility is shown on Figure 1-3. The plant is considered a temporary installation, to be relocated about 1980. The area stretching from the final oxidation ponds to the confluence of both creeks is currently being converted to a municipal golf course. Presently, plans are to use pond effluent for irrigation. The plant has a design capacity of 3 mgd with a current average daily allowable discharge.

A 42-inch sewer conveys sewage to the lift station at a depth of 30 feet. Lift station pumps bring the sewage to the entrance structure where it passes a comminuter. The entrance structure also incorporates a flow indicator, a bar screen and an automatic compositor. From the entrance structure, the waste flows by gravity to the aeration basins with surface aerators. Part of the flow goes to Basin A while the remainder is divided over Basins B and C.

Effluent from Aeration Basin A flows by gravity to a series of three small oxidation ponds with an overflow into three large stabilization ponds which also receive effluent from Aeration Basins B and C. Evaporation and exfiltration has precluded any discharge from the stabilization ponds. Upon completion of the golf course, the ponds will provide irrigation water. Since pervious limestone underlies the entire area, percolation of pond water into the creeks probably occurs, however, no

evidence of creek water quality deterioration has been found. The plant has experienced few mechanical and operational problems; maintenance and housekeeping are excellent. Minor routine monitoring tests are performed in the plant laboratory by the resident operator.

The Walnut Creek Sewage Treatment Plant.

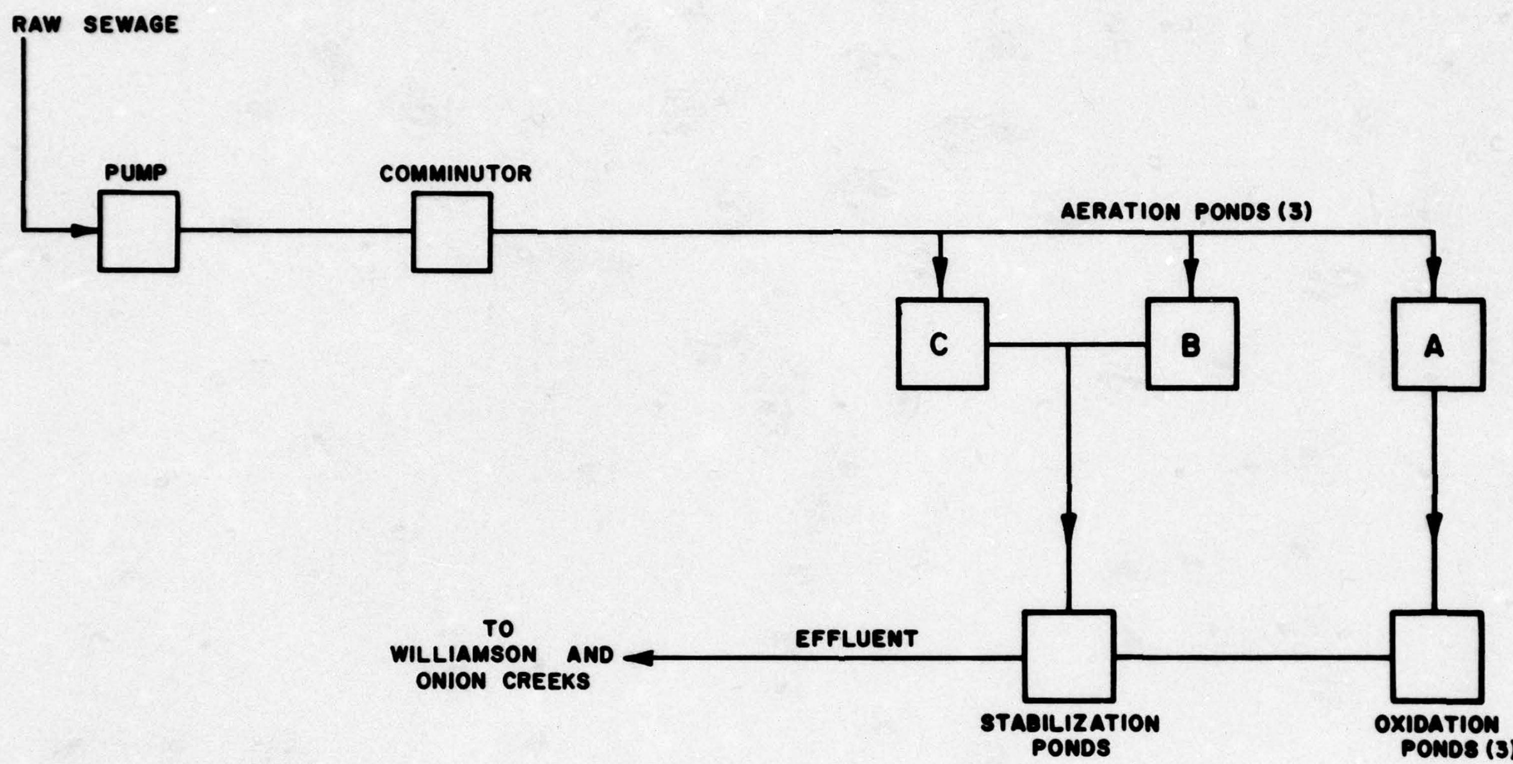
The Walnut Creek Sewage Treatment Plant is located east of the City of Austin on Webberville Road (F.M. 969). The facility has a design capacity of 2.5 mgd average dry weather flow. Current average dry weather flow is 1.4 mgd. The present facility will be replaced by an activated sludge process plant which is currently in the final design stage. A schematic layout of the present facility is shown in Figure 1-4.

New pretreatment facilities will be designed for 27 mgd average flow and 131 mgd storm flow in accordance with the Crosstown Interceptor Tunnel capacity. The secondary treatment facilities are designed for 18 mgd average flow and 24 mgd peak flow. Future expansion is limited due to planned construction of a municipal golf course on the remaining acreage. Waste sludge will be disposed of at the Hornsby Bend oxidation ponds. At present, sewage reaches the two aeration basins via an entrance structure with a comminuter. After aeration, the waste flows to two oxidation ponds from where it can be discharged to Walnut Creek if necessary. With both ponds in use, evaportion and percolation has precluded any discharge.

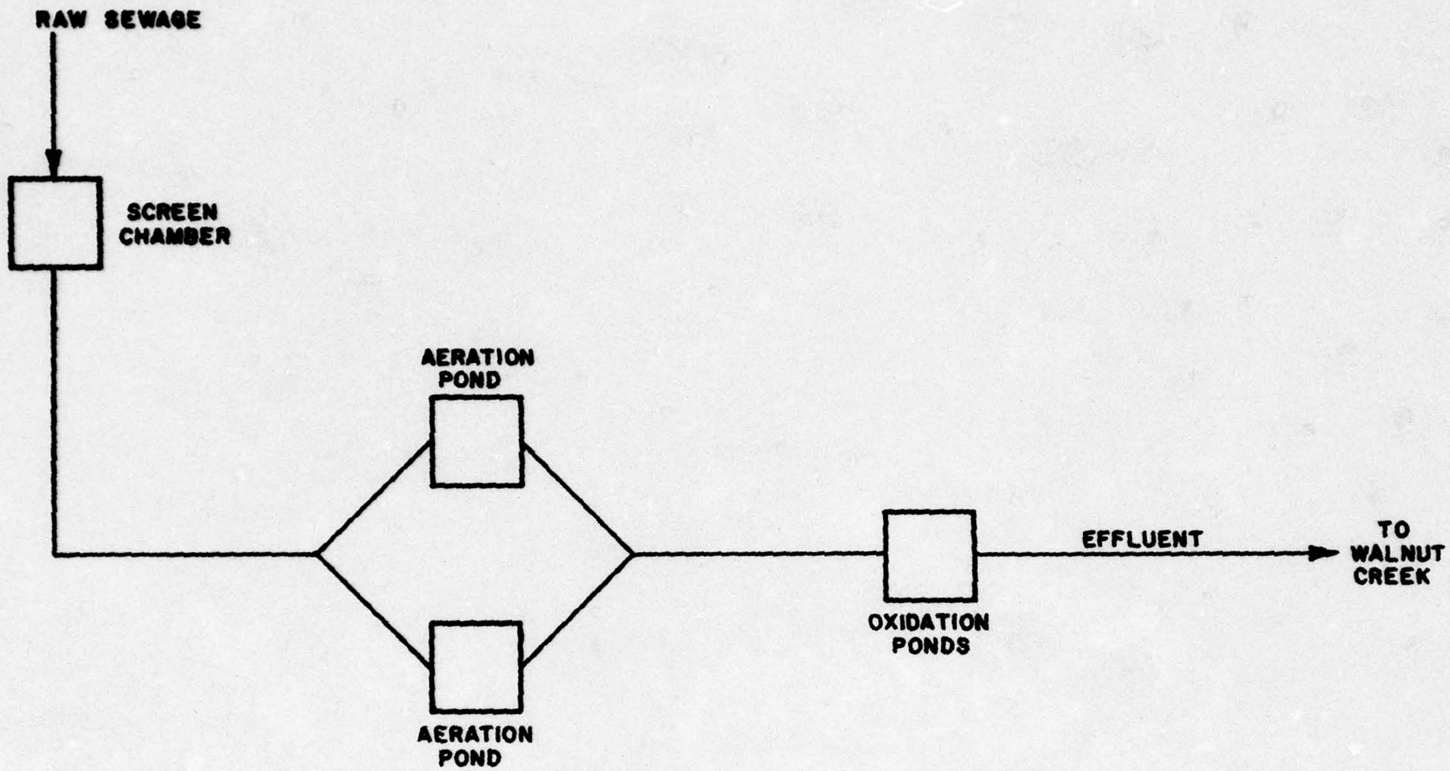
Conclusions.

All treatment plants function well, with occasional operational problems occurring, usually associated with industrial wastes or the advanced age of some of the facilities and equipment.

Some problems in particular at Govalle persist as a direct consequence of possible design inadequacies. The Williamson Creek and Walnut Creek plants are fairly self-sufficient as far as operation and maintenance are concerned.



FLOW DIAGRAM
WILLIAMSON CREEK SEWAGE TREATMENT PLANT
FIGURE 1-3



FLOW DIAGRAM
WALNUT CREEK SEWAGE TREATMENT PLANT
FIGURE 1-4

APPENDIX B

Evaluation Analysis of Alternatives

Appendix B presents an evaluation of the five most viable alternatives with respect to environment, social, economic, technological, and resource conservation considerations. In order to maintain the time schedule allotted for the study, the investigations of the foregoing features were conducted in a general manner with emphasis on their relation to the overall system evaluation. While detailed studies were not made on the specific features, these items were investigated to a degree that would uphold the integrity of the validity of the alternative evaluation process. The current status of the existing wastewater treatment facility was used as the base condition from which the evaluations were made.

AUSTIN, TEXAS

Evaluation Analysis

	ALTERNATIVE A1: Existing and new plants, phased implementation, activated sludge biological (partial tertiary).	ALTERNATIVE A2: Regional new plant, phased implementation, activated sludge biological (partial tertiary).	ALTERNATIVE B4A: Regional new plant, immediate implementation, activated sludge biological (full tertiary).	ALTERNATIVE B4C: Regional new plant, immediate implementation, physical chemical (full tertiary).	ALTERNATIVE B5: Existing and new plants, immediate implementation, activated sludge biological secondary and spray irrigation land disposal (full tertiary).
A. Environmental Quality					
1. Water Resource					
a. Effluent Quality	Removal of BOD/SS would approach 96%. Better removal of phosphorus than overland runoff.	Removal of BOD/SS would approach 96%. Better removal of phosphorus than overland runoff.	Removal of BOD/SS would approach 98%. Better removal of phosphorus than overland runoff.	Removal of BOD/SS would approach 98%. Better removal of phosphorus than overland runoff.	Removal of BOD and SS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients. Best removal of phosphorus.
b. Groundwater	Positive potential for recharge through streambed. This alternative probably will not be used for recharge, instead for industrial reuse or streamflow supplement.	Positive potential for recharge through streambed. This alternative probably will not be used for recharge, instead for industrial reuse or streamflow supplement.	Positive potential for recharge through streambed. This alternative probably will not be used for recharge, instead for industrial reuse or streamflow supplement.	Positive potential for recharge through streambed. This alternative probably will not be used for recharge, instead for industrial reuse or streamflow supplement.	Positive potential for recharge. No detrimental effect due to high quality water.
c. Streamflow	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	Decrease in streamflow as result of effluent diversion to irrigation operation. No flow to streams other than small flow from percolation.
2. Air Resource					
a. Odors	No odor problem anticipated from properly operated activated sludge facility.	No odor problem anticipated from properly operated activated sludge facility.	No odor problem anticipated from properly operated activated sludge facility. Carbon regeneration could cause problems.	Carbon regeneration could cause problems.	No odor problem anticipated from properly operated activated sludge facility.
b. Other Sources	Aerosol potential slight.	Aerosol potential slight.	Aerosol potential slight.	Possible sludge handling problems.	Aerosol potential slight.

AUSTIN, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE A1	ALTERNATIVE A2	ALTERNATIVE B4A	ALTERNATIVE B4C	ALTERNATIVE B5
A. Environmental Quality (Cont'd.)					
3. Land Resource					
a. Land Quality	Small land requirement minimizes minimum facility impact.	Small land requirement minimizes minimum facility impact.	Small land requirement minimizes minimum facility impact.	Small land requirement minimizes minimum facility impact.	Increased productivity under irrigation.
b. Land Utilization	Small land requirements. Land released for other uses.	Small land requirements. Land released for other uses.	Small land requirements. Land released for other uses.	Small land requirements. Land released for other uses.	Large area requirement. Committed for long period of time.
4. Biological					
a. Zoological	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Would change wildlife habitat characteristics. Probably increase species diversity and total number.
b. Botanical	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing.
5. Geological	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	Small land requirement minimizes facility impact.	If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge.
B. Social					
1. Manpower	Additional personnel required. Skilled technical personnel may not be available locally.	Additional personnel required. Skilled technical personnel may not be available locally.	Additional personnel required. Highly skilled technical personnel may not be available locally.	Additional personnel required. Highly skilled technical personnel may not be available locally.	Additional personnel required. Non-technical for land disposal system locally available.
2. Aesthetics	Visual impression will be matter of good architectural design and site maintenance.	Visual impression will be matter of good architectural design and site maintenance.	Visual impression will be matter of good architectural design and site maintenance.	Visual impression will be matter of good architectural design and site maintenance.	Land disposal site could be used to influence direction of growth—utilized as green belt.

AUSTIN, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE A1	ALTERNATIVE A2	ALTERNATIVE B4A	ALTERNATIVE B4C	ALTERNATIVE B5
B. Social (Cont'd.)					
3. Political Acceptability	Acceptable due to efficiency of concept and protection provided at minimum cost.	Abandonment of existing facilities will not be acceptable due to investment in facilities.	Abandonment of existing facilities will not be acceptable due to investment in facilities. Need for excessive treatment must be demonstrated.	Abandonment of existing facilities will not be acceptable due to investment in facilities. Need for excessive treatment must be demonstrated.	Dedication of large areas to wastewater renovation unacceptable to populace. Possible objections to increase of city owned land if leasing is not available.
C. Economic	Additional employment required. Costs represent minimum investment in preservation of water quality.	Additional employment required but less than non-regional concept.	Additional employment required but less than non-regional concept. Excessive full tertiary costs.	Additional employment required but less than non-regional concept. Excessive full tertiary costs.	Increased agricultural revenue. Additional employment required. (Regional effect.)
D. Technology					
1. Reliability/ Flexibility	More flexible. Effluent available directly for many uses.	More flexible. Effluent available directly for many uses.	More flexible. Effluent available directly for many uses.	More flexible. Effluent available directly for many uses.	More reliable. Effluent quality not as susceptible to load variations or influent quality.
2. Construction Effects	Less detrimental because of smaller land requirements.	Less detrimental because of smaller land requirements.	Less detrimental because of smaller land requirements.	Less detrimental because of smaller land requirements.	Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible.
E. Institutional Arrangements	No changes foreseen except for possible increase in work force technical level.	No changes foreseen except for possible increase in work force technical level.	Change could be required to restructure functions and responsibilities of public works departments.	Change could be required to restructure functions and responsibilities of public works departments.	Some structure change necessary if city operates land disposal systems. Difficulties could be encountered if contract with farmer(s) for operation of irrigation systems.
F. Resource Conservation	Normal levels of resource utilization required.	Normal levels of resource utilization required.	Normal levels of resource utilization required.	Chemical requirements would commit large quantities of non-renewable resources.	Large land areas would be committed for many years.

APPENDIX C

Economic Analysis of Alternatives

Each of the wastewater treatment facility alternatives for Austin was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by which an item is to be operational, the capital cost of each item and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost, Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10 respectively. All values shown are in January 1972 dollars.

AUSTIN, TEXAS

Cost Summary

Alternative Interest Rate (Percent)	Total Present Worth* 5.5	7.0	10.0
A1	$106,251,896	$ 84,335,804	$56,934,427
A2	120,889,168	99,600,223	72,317,901
B1	152,890,973	125,437,874	90,393,933
B2	151,817,377	128,102,511	96,950,399
B3	148,138,870	120,949,799	86,421,652
B4A	150,001,854	125,107,224	93,077,219
B4B	151,298,780	127,724,431	97,215,082
B4C	143,573,280	118,663,515	86,919,976
B5	105,115,515	87,612,336	64,798,649
B6	138,995,750	116,937,994	88,242,038
B7	119,163,157	100,201,327	75,254,712
B8	153,043,391	129,526,984	98,698,101
B9	109,364,487	90,198,100	65,603,305
B10	143,244,721	119,523,758	89,046,694

*Total Present Worth is equal to the Capital Cost Present Worth plus the Present Worth of operation and maintenance.

Austin Alternatives

Cost Comparison

ALTERNATIVE A1

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CREEK	1975	5587200.	427000.	4758136.	6017399.	10775535.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
ONION CREEK	1980	3034200.	79000.	1977081.	825995.	2803077.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	6733700.	1233900.	3736601.	10732051.	14468651.
GOVALLE	1983	3107400.	1568700.	1724329.	13644029.	15368358.
ONION CREEK	1983	1247800.	256400.	692417.	2230082.	2922499.
WALNUT CREEK	1985	2733100.	328000.	1362616.	2516785.	3879401.
GOVALLE	1985	2623000.	310300.	1307725.	2380970.	3688695.
ONION CREEK	1985	2678200.	422800.	1335245.	3244197.	4579442.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	2338000.	128500.	719930.	540604.	1260534.
WALNUT CREEK	1998	6163900.	556300.	1532116.	1739944.	3272060.
ONION CREEK	2009	4209200.	384400.	580575.	429069.	1009644.
WALNUT CREEK	2010	6163900.	590900.	805865.	582311.	1388176.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		94958100.	236910500.	51005043.	55246853.	106251896.
INT RT=.070000		94958100.	236910500.	44484040.	39851764.	84335804.
INT RT=.100000		94958100.	236910500.	34624517.	22309910.	56934427.

ALTERNATIVE A2

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PREC WORTH
ONION CREEK RL	1975	10449000.	876000.	8898511.	12344828.	21243339.
INTERCEPTORS	1975	17036000.	469200.	14508090.	6612093.	21120183.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
ONION CREEK RL	1983	4310500.	1330500.	2391942.	11572245.	13964187.
ONION CREEK RL	1985	15001600.	1826700.	7479208.	14016496.	21495704.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK RL	2005	12104600.	1304900.	2068327.	2238078.	4306405.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		107118600.	225467500.	65714929.	55174239.	120889168.
INT RT=.070000		107118600.	225467500.	59058084.	40542139.	99600223.
INT RT=.100000		107118600.	225467500.	48640422.	23677479.	72317901.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE B1

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CREEK	1975	14500000.	1642500.	12348398.	23146552.	35494951.
GOVALLE AS TTY	1975	11600000.	2182700.	9878719.	30759196.	40637915.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
ONION CREEK	1980	8134000.	736000.	5300105.	7695349.	12995454.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	9288000.	708100.	5154009.	6158818.	11312826.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	6512800.	452600.	2005458.	1904103.	3909561.
WALNUT CREEK	1998	9288000.	700800.	2308651.	2191897.	4500548.
ONION CREEK	2009	6512800.	423400.	898311.	472601.	1370912.
WALNUT CREEK	2010	9288000.	627800.	1214308.	618675.	1832982.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		123462100.	304391300.	69580365.	83310609.	152890973.
INT RT=.070000		123462100.	304391300.	61914758.	63523116.	125437874.
INT RT=.100000		123462100.	304391300.	50382980.	40010953.	90393933.

ALTERNATIVE B2

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CREEK	1975	19686000.	1182600.	16764867.	16665518.	33430384.
GOVALLE TF TTY	1975	26634000.	1537400.	22681878.	21665455.	44347333.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
ONION CREEK	1980	9296000.	531600.	6057263.	5558216.	11615480.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	11600000.	452600.	6436962.	3936564.	10373526.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	7553000.	299300.	2325763.	1259165.	3584928.
WALNUT CREEK	1998	11600000.	445300.	2883328.	1392768.	4276096.
ONION CREEK	2009	7553000.	306600.	1041786.	342228.	1384014.
WALNUT CREEK	2010	11600000.	459900.	1516577.	453215.	1969792.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		153860500.	224457200.	90180830.	61636547.	151817377.
INT RT=.070000		153860500.	224457200.	81089779.	47012731.	128102511.
INT RT=.100000		153860500.	224457200.	67341165.	29609235.	96950399.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 83

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CREEK	1975	9288000.	1708200.	7909788.	24072414.	31982202.
GOVALLE PC TTY	1975	12760000.	2372500.	10866590.	33433909.	44300499.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
ONION CREEK	1980	5126000.	794400.	3340096.	8305958.	11646054.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	6052800.	744600.	3358762.	6476282.	9835045.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	4197600.	445300.	1292549.	1873392.	3165941.
WALNUT CREEK	1998	6052800.	737300.	1504501.	2306059.	3810559.
ONION CREEK	2009	4197600.	481800.	578975.	537787.	1116762.
WALNUT CREEK	2010	6052800.	664300.	791340.	654644.	1445984.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		102066100.	321195900.	60115007.	88023863.	148138870.
INT RT=.070000		102066100.	321195900.	53803001.	67146798.	120949799.
INT RT=.100000		102066100.	321195900.	44091038.	42330614.	86421652.

ALTERNATIVE 84A

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
RL AS TERTIARY	1975	26634000.	3066000.	22681878.	43206898.	65888776.
INTERCEPTORS	1975	17036000.	469200.	14508090.	6612093.	21120183.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
RL AS TERTIARY	1988	18544000.	1679000.	7873432.	10624780.	18498212.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
RL AS TERTIARY	2005	18544000.	1496500.	3168635.	2566697.	5735332.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		128974900.	267456500.	78600886.	71400968.	150001854.
INT RT=.070000		128974900.	267456500.	70968869.	54138355.	125107224.
INT RT=.100000		128974900.	267456500.	59257193.	33820026.	93077219.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE B4B

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
RL TF TERTIARY	1975	39338000.	2190000.	33500778.	30862070.	64362848.
INTERCEPTORS	1975	17036000.	469200.	14508090.	6612093.	21120183.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
RL TF TERTIARY	1988	25476000.	1131500.	10816628.	7160178.	17976806.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
RL TF TERTIARY	2005	25476000.	2755750.	4353114.	4726479.	9079593.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		155542900.	229405250.	93547461.	57751319.	151298780.
INT RT=.070000		155542900.	229405250.	84430576.	43293855.	127724431.
INT RT=.100000		155542900.	229405250.	70608971.	26606111.	97215082.

ALTERNATIVE B4C

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
RL PC TERTIARY	1975	17385000.	3358000.	14805304.	47321840.	62127144.
INTERCEPTORS	1975	17036000.	469200.	14508090.	6612093.	21120183.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
RL PC TERTIARY	1988	11600000.	1861500.	4925141.	11779648.	16704788.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
RL PC TERTIARY	2005	11600000.	1679000.	1982106.	2879709.	4861815.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		105837900.	289174000.	66589490.	76983790.	143573280.
INT RT=.070000		105837900.	289174000.	60322119.	58341396.	118663515.
INT RT=.100000		105837900.	289174000.	50498080.	36421897.	86919976.

ALTERNATIVE B5

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK AS	1975	5587200.	427000.	4758136.	6017399.	10775535.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
SI LT TERTIARY	1975	16407600.	1494000.	13972936.	21053850.	35026787.
ONION CREEK	1980	3034200.	79000.	1977081.	825995.	2803077.
SI LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE B5

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	3489000.	237300.	1936083.	2063956.	4000039.
SI LT TERTIARY	1990	3212600.	377000.	1225497.	2090136.	3315634.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	2338000.	128500.	719930.	540604.	1260534.
WALNUT CREEK	1998	3489000.	167900.	867235.	525142.	1392377.
SI LT TERTIARY	2000	7526500.	638200.	1680832.	1703216.	3384048.
ONION CREEK	2009	2338000.	127000.	322481.	141758.	464238.
WALNUT CREEK	2010	3489000.	219000.	456150.	215817.	671967.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		99989000.	174269900.	58870560.	46244956.	105115515.
INT RT=.070000		99989000.	174269900.	52627554.	34984783.	87612336.
INT RT=.100000		99989000.	174269900.	43054503.	21744146.	64798649.

ALTERNATIVE B6

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK AS	1975	5587200.	427000.	4758136.	6017399.	10775535.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
OR LT TERTIARY	1975	38529900.	2112200.	32812589.	29765691.	62578281.
ONION CREEK	1980	3034200.	79000.	1977081.	825995.	2803077.
OR LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	3489000.	237300.	1936083.	2063956.	4000039.
OR LT TERTIARY	1990	9767800.	583670.	3726083.	3235941.	6962024.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	2338000.	128500.	719930.	540604.	1260534.
WALNUT CREEK	1998	3489000.	167900.	867235.	525142.	1392377.
OR LT TERTIARY	2000	13488000.	1144430.	3012165.	3054233.	6066398.
ONION CREEK	2009	2338000.	127000.	322481.	141758.	464238.
WALNUT CREEK	2010	3489000.	219000.	456150.	215817.	671967.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		134628000.	218413600.	81542131.	57453619.	138995750.
INT RT=.070000		134628000.	218413600.	73522010.	43415984.	116937994.
INT RT=.100000		134628000.	218413600.	61267715.	26974323.	88242030.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 87

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK TF	1975	14732000.	354780.	12545973.	4999655.	17545628.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
SI LT TERTIARY	1975	16407600.	1494000.	13972936.	21053850.	35026787.
ONION CREEK	1980	6975000.	49800.	4544902.	520691.	5065593.
SI LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	8479000.	156220.	4705086.	1358749.	6063836.
SI LT TERTIARY	1990	3212600.	377000.	1225497.	2090136.	3315634.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	5238000.	106580.	1612915.	448386.	2061300.
WALNUT CREEK	1998	8479000.	154760.	2107564.	484044.	2591608.
SI LT TERTIARY	2000	7526500.	638200.	1680832.	1703216.	3384048.
ONION CREEK	2009	5238000.	90520.	722478.	101039.	823517.
WALNUT CREEK	2010	8479000.	157680.	1108539.	155388.	1263928.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		133844600.	164978560.	75180920.	43982237.	119163157.
INT RT=.070000		133844600.	164978560.	66889318.	33312009.	100201327.
INT RT=.100000		133844600.	164978560.	54506136.	20748577.	75254712.

ALTERNATIVE 88

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK TF	1975	14732000.	354780.	12545973.	4999655.	17545628.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
OR LT TERTIARY	1975	38529900.	2112200.	32812589.	29765691.	62578281.
ONION CREEK	1980	6975000.	49800.	4544902.	520691.	5065593.
OR LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8328960.	38328637.
WALNUT CREEK	1983	8479000.	156220.	4705086.	1358749.	6063836.
OR LT TERTIARY	1990	9767800.	583670.	3726083.	3235941.	6962024.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	5238000.	106580.	1612915.	448386.	2061300.
WALNUT CREEK	1998	8479000.	154760.	2107564.	484044.	2591608.
OR LT TERTIARY	2000	13488000.	1144430.	3012165.	3054233.	6066398.
ONION CREEK	2009	5238000.	90520.	722478.	101039.	823517.
WALNUT CREEK	2010	8479000.	157680.	1108539.	155388.	1263928.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE B8

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
INT RT=.055000		168483600.	209122260.	97052491.	55190900.	153043391.
INT RT=.070000		168483600.	209122260.	87783774.	41743210.	129526984.
INT RT=.100000		168483600.	209122260.	72719348.	25978753.	98698101.

ALTERNATIVE B9

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK PC	1975	3269000.	768700.	2783925.	10832727.	13616653.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
SI LT TERTIARY	1975	16407600.	1494000.	13972936.	21053850.	35026787.
ONION CREEK	1980	1704500.	239600.	1110650.	2505171.	3615821.
SI LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.
COLLECTION SYS	1980	46040100.	796600.	29999677.	8320960.	38320637.
WALNUT CREEK	1983	1993300.	355500.	1106103.	3092020.	4198124.
SI LT TERTIARY	1990	3212600.	377000.	1225497.	2090136.	3315634.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	1563500.	233600.	481442.	982763.	1464205.
WALNUT CREEK	1998	1993300.	373800.	495460.	1169137.	1664597.
SI LT TERTIARY	2000	7520500.	630200.	1680832.	1703216.	3384048.
ONION CREEK	2009	1563500.	219000.	215654.	244449.	460102.
WALNUT CREEK	2010	1993300.	341600.	260603.	336635.	597238.
COLLECTION SYS	2020	1512500.	25800.	115765.	0.	115765.
INT RT=.055000		90305000.	209944200.	54287301.	55077187.	109364487.
INT RT=.070000		90305000.	209944200.	48640633.	41557467.	90198100.
INT RT=.100000		90305000.	209944200.	39884850.	25718455.	65603305.

ALTERNATIVE B10

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
WALNUT CK PC	1975	3269000.	768700.	2783925.	10832727.	13616653.
WILLIAMSON CK	1975	121600.	140000.	103556.	1972918.	2076474.
OK LT TERTIARY	1975	38529900.	2112200.	32812509.	29705691.	62570201.
ONION CREEK	1980	1704500.	239600.	1110650.	2505171.	3615821.
OK LT TERTIARY	1980	739400.	67300.	481792.	703664.	1185457.

Austin Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE B10

ITEM	DATE	CAPITAL COST	O+M COST	CAP COST PRES WORTH	O+M PRES WORTH	TOTAL PRES WORTH
COLLECTION SYS	1980	66040100.	790600.	29999677.	8320960.	38320637.
WALNUT CREEK	1983	1993300.	355500.	1106103.	3092020.	4198124.
ON LT TERTIARY	1990	9767000.	503670.	3726083.	3235941.	6962024.
COLLECTION SYS	1990	664300.	11100.	253408.	61540.	314948.
ONION CREEK	1994	1563500.	233600.	481442.	982763.	1464205.
WALNUT CREEK	1998	1993300.	373800.	495460.	1169137.	1664597.
ON LT TERTIARY	2000	13400000.	1100430.	3012105.	3054233.	6066338.
ONION CREEK	2009	1563500.	219000.	215654.	244448.	460102.
WALNUT CREEK	2010	1993300.	341600.	260603.	336635.	597238.
COLLECTION SYS	2020	1512500.	25000.	115765.	0.	115765.
INT RT=.055000		124944000.	254007900.	76950672.	66294049.	143244721.
INT RT=.070000		124944000.	254007900.	69535009.	49988749.	119523758.
INT RT=.100000		124944000.	254007900.	58050062.	30980632.	89030694.

APPENDIX D

Land Disposal Alternatives
City of Austin, Texas

Evaluation of Land Disposal Methods.

In evaluating land disposal as a method of advanced wastewater treatment for the Austin metropolitan area, the first items to consider are the soil types and properties in this area. The projected land use must also be reviewed concurrently with the soil maps. From land use projections, the area which could be considered for land disposal generally was found to lie in the southeast portion of Travis County, south of U.S. 290 and east of I.H. 35. This portion of the study area was also chosen due to the absence of soil types such as the Brackett-Tarrant and Crawford-Tarrant Clays. These soils are characterized by a thin clay layer (3 to 15 inches thick) underlain by broken limestone or limestone bedrock. The most obvious reason for avoiding these soils is the possibility of direct ground water contamination through cracks in the limestone bedrock.

The general soil types found in the area under consideration are briefly summarized below:

Austin-Houston Black Soils.

Austin - dark grayish brown, calcareous, silty clay to clay surface, 10 to 14 inches thick; over brown to pale brown, friable, strongly granular, highly calcareous, silty clay to clay. Chalky marl on chalk at depths of about 15 to 30 inches, depth to bedrock is from 24 to 54 inches. Permeability ranges from 0.20 to 0.63 inches per hour; 1 to 10 percent slopes.

Houston Black - very dark gray to black, crumbly, friable, calcareous clay surface, 10 to 25 inches thick; over dark gray or olive gray, firm, calcareous clay, with strongly calcareous, mottled yellow and gray clay at 30 to 60 inches; depth to bedrock is greater than 60 inches. Permeability is reported to be less than 0.06 inches per hour; 1 to 4 percent slopes.

Houston Black-Houston Soils

Houston Black - described above

Houston - dark olive gray to dark grayish brown, crumbly calcareous, clay surface, 6 to 15 inches thick; over dark yellowish brown, subangular, blocky, highly calcareous clay with yellow mottling in lower part; highly calcareous mottled yellow and gray clay at 20 to 36 inches; depth to bedrock greater than 60 inches; permeability is reported to be less than 0.06 inches per hour; 4 to 8 percent slopes.

Houston-Sumter Clays

Houston - described above

Sumter - dark yellowish brown to olive, crumbly, strongly calcareous surface, 4 to 10 inches thick; over mottled pale olive and yellowish brown, very firm, strongly calcareous clay; depth to bedrock unknown, assumed to be the same as for Houston soils; permeability also unknown, assumed to be the same as for Houston soils; 7 to 15 percent slopes.

Milam-Travis Sandy Loams

Milam - grayish brown to light grayish brown, very friable, acid surface, 9 to 15 inches thick; over red, friable, massive, acid, sandy clay; depth to bedrock unknown, assumed to be the same as for Travis soils; permeability unknown, assumed to be the same as for Travis soils; 0 to 2 percent slopes.

Travis - brown to pale brown, friable, slightly acid to neutral surface, 10 to 15 inches thick; over red, very firm, blocky, acid sandy clay; depth to bedrock is greater than 60 inches; permeability varies from 0 to 14 inches; permeability ranges from 2.0 to 6.3 inches per hour; from 14 to 50 inches permeability ranges from 0.06 to 0.2 inches per hour; from 50 to 75 inches permeability ranges from 0.63 to 2.0 inches per hour; 1 to 6 percent slopes.

Norwood-Yahola Soils

Norwood - reddish brown to dark reddish brown, friable, strongly calcareous, silt loam to silty clay loam, 9 to 25 inches thick; over light reddish brown very friable, granular, silt loam or silty clay loam several feet thick; depth to bedrock greater than 60 inches; permeability ranges from 0.63 to 2.0 inches per hour; 0 to 2 percent slopes.

Yahola - light reddish brown, calcareous, very fine, sandy loam to silt loam surface, 6 to 30 inches thick; over stratified, calcareous, reddish, loamy sands and sandy loams; depth to bedrock greater than 60 inches; permeability ranges from 2 to 6.3 inches per hour; nearly level floodplains.

Travis-Axtell Soils

Travis - described above

Axtell - light brownish gray to pale brown, friable, acid, fine sandy loam surface, 5 to 10 inches thick; over mottled reddish brown and yellowish brown, very firm, very plastic, blocky, acid clay which has increasing mottling with depth; depth to bedrock unknown, assumed to be the same as for Travis soils; permeability unknown, assumed to be the same as for Travis soils; 0 to 2 percent slopes.

Trinity-Bell Soils

Trinity - very dark, gray, crumbly, calcareous surface, 20 to 40 inches thick; over dark gray, firm, calcareous clay; depth to bedrock greater than 60 inches; permeability is less than 0.06 inches per hour; nearly level floodplains.

Bell - very dark gray, granular, calcareous surface, 10 to 20 inches thick; over dark gray to gray, very firm, weakly blocky, calcareous clay; depth to bedrock unknown, assumed to be the same as for Trinity soils; permeability unknown, assumed to be the same as for Trinity soils; 0 to 2 percent slopes.

The following tabulation was taken from the CRREL Special Report 171, which states that "a general correlation is possible between desired land disposal characteristics and the drainage characteristics of the Unified Soil Classification System used by the Corps of Engineers and others." Since it is not uncommon to find impervious soils underlying very pervious ones, the lowest percolation capacity within the depth of interest must be established as the controlling criteria.

LAND DISPOSAL/UNIFIED SOIL CLASSIFICATION

Symbol	Type	Drainage Characteristics	Potential Land Disposal Mode
GW	Well graded gravels or gravel-sands, little or no fines	Excellent	RI
GP	Poorly graded gravels gravel-sands, little or no fines	Excellent	RI
GM-d	Silty gravels, gravel-sand-silt mixtures	Fair to poor	SI
GM-u	Silty gravels, gravel-sand-silt mixtures	Poor to practically impervious	OR
GC	Clayey gravels, gravel-sand-clay mixtures	Poor to practically impervious	OR
SW	Well graded sands or gravelly sand, little or no fines	Excellent	RI
SP	Poorly graded sands or gravelly sands, little or no fines	Excellent	RI

Symbol	Type	Drainage Characteristics	Potential Land Disposal Mode
SM-d	Silty sands, sand-silt mix	Fair to poor	SI
SM-u	Silty sands, sand-silt mix	Poor to practically impervious	OR
SC	Clayey sands, sand-clay mixtures	Poor to practically impervious	OR
ML	Inorganic silts, very fine sands, silty or clayey sands	Fair to poor	SI
CL	Inorganic clays, gravelly clays, sandy clays, silty clays, lean clays	Practically impervious	OR
OL	Organic silts, organic silt clays or low plasticity	Poor	SI-OR
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils	Fair to poor	SI
CH	Inorganic clays of high plasticity, fat clays	Practically impervious	OR
OH	Organic clays of medium to high plasticity, organic silts	Practically impervious	OR
PT	Peat and other highly organic soils	Fair to poor	SI

A tabulation of the soil series under consideration in Travis County for which the Unified Classification is available is given below along with the classifications.

TRAVIS COUNTY SOILS

Soil Series	Depth from Surface (in.)	Classification (unified)
Austin	0-34	CH, CL
	34-48	CL
	48-52	-
Houston Black	0-104	CH
Norwood	0-18	CL
	18-60	CL or ML
Travis	0-14	SM
	14-50	SC
	50-75	GC, SC
Trinity	0-38	CH
	38-74	GC
	74-96	CH
Yahola	0-14	CL, CL-ML, ML
	14-20	CL or ML
	20-34	ML
	34-40	CL, CL-ML
	40-52	ML
	52-60	CL, ML

From the above information, each soil series and their potential land disposal method were determined as shown below.

SOIL SUITABILITY

Land Disposal Method	Potential Soil Series Available
a. Spray Irrigation	Milam-Travis. Norwood-Yahola, Travis-Axtell
b. Overland Runoff	Austin-Houston Black, Houston Black-Houston Houston-Sumter, Trinity-Bell
c. Rapid Infiltration	Patrick

AD-A036 850 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2
WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
SEP 73

UNCLASSIFIED NL

3 OF 5
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A036850

Rapid Infiltration - in reviewing the soil series found in T the Lincoln and Patrick Series were the only two which sl potential for rapid infiltration. These soils are reportedl major streams and may generally be located where road are mined (gravel pits). The soil summary sheet describ Series referred to one particular location of this type in ' 500 feet south of the junction of U.S. 183 and Onion Creel feet east of U.S. 183. A brief description of some of the this series is given below.

Patrick Series

General Soil Profile (inches)	Classification (Unified)
0 - 10	CL
10 - 22	CL
22 - 72+	GM, GC, or GW

The characteristics of the soil below 22 inches seem to b rapid infiltration method of disposal. However, the dept given only as more than 12 feet. According to CRREL S "Knowledge of surficial soil characteristics alone is not must be developed on subsurface soils to depths of at lea on ground water conditions including vertical and horizor horizontal permeability, to permit proper lateral movem water". In reviewing the general geology of the Austin a crops of bedrock occur in the western part of the City, w ring in the downtown area 15 to 20 feet below the surface Series soils occur along the stream terraces and were c time in geologic history by the streams, it is logical to a streams recharge and are recharged by these deposits. water entering these deposits would reach the adjacent s short distance and time (not desirable for proper renova

Due to the above discussion it is recommended that rapi be considered in this report as a potential method of lan Austin area because of the lack of required soil informa short renovative distance and travel time available.

Spray Irrigation

This method of land disposal appears to be the most reli with the least application and operation problems. The determined in designing a spray irrigation field, once a is found, is the application rate. In this part of the cour gation is practiced on a year-round basis and not on a 's and hold for three months" schedule that is practiced in due to ground freezing during the winter.

The application rate can be expressed as the sum of the gross evaporation, the gross transpiration, and the rate of infiltration less the gross rainfall. For planning purposes, the potential evaporation can be expressed as the evaporation rate as measured in standard 4-foot Class A Weather Bureau Evaporation Pans.[1]

The net reservoir evaporation rates as given in "Monthly Reservoir Evaporation Rates for Texas, 1940 through 1965," TWDB Report 64, were assumed to reflect the gross evapotranspiration less the gross rainfall for this study. The evaporation rates for the Austin quadrangle are given below:

Evaporation Rates

Winter Months	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
(Net Evaporation in feet)	0.11	0.03	0.04	0.01	0.16	0.07
Summer Months	May	June	July	Aug.	Sep.	Oct.
(Net Evaporation in feet)	0.19	0.32	0.59	0.62	0.36	0.26

The winter and summer months division as given above were arbitrarily chosen after reviewing each month's net evaporation. The average net evaporation rate for the winter months is 0.07 feet per month. The average summer evaporation rate is 0.39 feet per month.

Winter Application Rate - The spray irrigation operation will be assumed to be conducted on the basis of one days application and six days of rest for aerobic and renovative conditions to exist in the soil. Therefore it will be assumed that there is an excess daily application equal to the weekly evaporation rate. The winter excess application rate would therefore be:

Excess Application Rate = (0.07 ft/mo) (12 mo/yr) (1 yr./52 wks) (12 in/ft) = 0.19 in/wk

Assuming day-time operators for a standard 8-hour work day, an 8-hour application period will be used. The infiltration rate available would then be equal to the permeability times the application period. The permeability available in the soils considered for spray irrigation will be assumed to have a minimum value of 0.63 inches per hour. Thus, the infiltration rate is:

Infiltration rate = (0.63 inches/hour) (8 hours/week) = 5.04 in/week
Winter Application rate = (5.04 + 0.19) = 5.23 in/week

Summer Application Rate - The summer application rate is determined in the same manner as the winter rate. The excess application rate would be 1.08 inches per week, and the infiltration rate from above would be 5.04 inches per week, therefore, the summer application rate is as follows:

1 Corps of Engineers Wastewater Management Report 72-1, page 22

Summer application rate - (5.04 + 1.08) = 6.12 in/week

Since year-round operation is necessary, the winter application rate will be used for design purposes.

The soils that are suitable for spray irrigation are found generally in a band along and north of the Colorado River. Therefore, it will be assumed that all secondary effluent from the three Austin plants would be pumped to a central holding facility and pump station for distribution to the spray fields rather than separate facilities for each plant. It will also be assumed that the facility will be designed for year 2020 projected sewage flows of 91,200,000 gallons per day. The net area required for the facility is as follows:

$$\text{Net Area Required} = (91{,}200{,}000 \text{ gal./day})(7 \text{ days/week})(1 \text{ ft}^3/7.48 \text{ gal.})* \\ *(\text{week}/5.23 \text{ in.})(12 \text{ in./ft.})(1 \text{ acre}/43{,}560 \text{ ft.}^2) \\ = 4{,}495.5 \text{ acres}$$

Application Equipment

There are several large commercial irrigating systems available which utilize large rotating arm type sprinklers. They are available in incremental sizes from 1/2 acre to 40 acres. This type of application equipment was also proposed for the Chicago-South End of Lake Michigan Area Wastewater Management Study. For the Austin area, it will be assumed that the larger 40-acre units would be utilized and specifications and cost estimates are based on the Aquatower system available from the McDowell Manufacturing Company. For design purposes a total system flow rate of 91,200,000 gallons per day was utilized. The design calculations are as follows:

Irrigation Equipment Calculations

Assume: (a) 40-acre Aquatower system (31.4 acres net); (b) 5.23 inches per week application rate, 627,600 gallons per day capacity,

$$\text{Units required} = \frac{91{,}200{,}000}{627{,}600} = 145.3 \text{ (utilize 146)}$$

Actual capacity = 146 (627,600 gpd) = 91,629,600 gallons per day

Estimated gross area = 146(40) = 5,840 acres

Estimated Land Cost: (5,840 acres) ($1,000/acre) = $5,840,000

Aquatower Capital Cost = 146($33,300) = $4,861,800

Engineering & Contingencies	797,300
Total	$5,659,100
Annual O & M Cost	$ 170,000

Annual depth/service unit assuming 6% interest and 10-year life = $4,524 per unit

Total Annual Cost of Aquatower system with 146 units - $830,500 not including supply pipelines, valves, pumps, land, etc.

Holding Facilities - It is recommended that a storage capacity be utilized capable of containing the flow for a seven-day period. The volume required (7 days x 91,200,000 gallons per day) would be 638,400,000 gallons. The volume of the Hornsby Bend oxidation ponds (assuming 191 surface acres, 4 feet deep) is 764 acre-feet, 33,279,840 cubic feet, or 248,926,920 gallons. Assuming these facilities are utilized for holding, an additional holding capacity or volume of 389,473,000 gallons would be required: 389,473,000 gallons = 52,068,582 cubic feet = 1,195 acre-feet. Assuming holding facilities 15 feet deep, the required surface area would be 80 acres.

Capital Cost, 80-acre lagoon	$1,928,500
Engineering & Contingencies	324,000
Total	$2,252,500
Annual O&M Cost, all lagoons	$ 250,000

Pumps and Transmission Facilities - Construct facilities capable of transferring effluent from sewage treatment plants to the holding ponds.

Walnut Creek Plant - A facility capable of pumping 170 million gallons per day would be required:

PUMPS
(119,000 gpm total capacity)

Capital Cost	$ 350,000
Engineering & Contingencies	69,300
Total	$ 419,300
Annual O&M Cost	$ 350,000

TRANSMISSION LINE

Size	Length	Unit Cost	Cost
78 in.	30,000 ft.	$70/ft.	$2,100,000
Engineering & Contingencies			352,800
Total			$2,452,800
Annual O&M Cost (Assume 2% Replacement Cost)			$ 42,000

Govalle Plant - A facility capable of pumping 90 million gallons per day would be required:

PUMPS
(63,000 gpm Total Capacity)

Capital Cost	$ 190,000
Engineering & Contingencies	38,500
Total	$ 228,500
Annual O&M Cost	$ 185,000

TRANSMISSION LINE

Size	Length	Unit Cost	Cost
60 in.	12,000 ft.	$50/ft.	$ 600,000
Engineering & Contingencies			109,200
Total			$ 709,200
Annual O&M Cost (Assume 2% Replacement Cost)			$ 12,000

Onion Creek Plant - A facility capable of pumping 70 million gallons per day would be required:

PUMPS
(49,000 gpm Total Capacity)

Capital Cost	$ 150,000
Engineering & Contingencies	31,300
Total	$ 181,300
Annual O&M Cost	$ 140,000

TRANSMISSION LINE

Size	Length	Unit Cost	Cost
54 in.	12,000 ft.	$47/ft.	$ 564,000
Engineering & Contingencies			104,300
Total			$ 668,300
Annual O&M Cost			$ 11,300

Pump Station and Supply Lines - Construct facilities capable of pumping from the holding facilities to the spray field would be required:

SUPPLY LINES

Capital Cost	$5,640,500
Engineering & Contingencies	925,000
Total	$6,565,500
Annual O&M Cost	$ 97,000

PUMP STATION
(91.2 mgd)

Capital Cost	$2,450,000
Engineering & Contingencies	409,100
Total	$2,859,100
Annual O&M Cost	$ 816,000

Overland Runoff

The design of an overland runoff land disposal system is not dependent upon a numerical value for permeability as in the case of spray irrigation, other than the requirement for an impermeable soil. Recommended slope criteria in the CFREL Special Report 171 are six percent maximum and two percent minimum, with a slope distance approaching 300 feet. The average application rate is recommended to be two inches per week on an intermittent basis.

In proposing such a facility for the City of Austin, the above criteria will be assumed along with the same application equipment as was proposed under the spray irrigation method. An application rate of two inches per week, on a basis of spraying eight hours in one day and then allowing a six-day rest or renovation period is assumed. For the purpose of cost estimation, it will be assumed that no extensive site preparation will be required and that native vegetation is suitable to this type of land disposal.

Overland runoff requires trenches spaced approximately 100 feet apart per each percent of slope to achieve a desired retention and contact time with the soil as recommended in the Corps of Engineers Wastewater Management Report 72-1. However, since it is impossible to estimate the cost of such trenching with any accuracy on such a large tract of land considered here, it will be assumed to be negligible with respect to other costs. The basic design parameters are given below. Net land area required (for year 2020) = 91,200,000 gallons per day divided by (2 in/wk) (ft/12 in) (43,560 ft^2/acre) (7.48 gal/ft^3) (wk/7 days) = 11,732.5 acres.

Application Equipment

Assuming 40-acre Aquatower systems (31.4 acres net) with a two-inch per week application rate and 240,000 gallons per day capacity:

APPLICATION EQUIPMENT

Units required = $\frac{91,200,000}{240,000}$ = 380 units

Estimated gross area required = (380) (40) = 15,200 acres

Estimated Land Cost: (15,200 acres) ($500/acre) = $7,600,000

Aquatower Capital Cost = 380 ($33,300) =	$12,654,000
Engineering & Contingencies	2,011,900
Total	$14,665,900
Annual O&M Cost	$ 442,500 (380 units)
Annual debit service per unit (*Assuming 6% Interest and 10-year Life*)	$ 4,524 per unit

Total Annual Cost of Aquatower system with 380 units = ($442,500) + (380) ($4,524) = $2,161,620 not including supply pipelines, valves, pumps, land, etc.

Holding Facilities

Assume the same facilities as proposed under the spray irrigation alternative:

COST SUMMARY

Capital Cost, 80-acre lagoon	$1,928,500
Engineering & Contingencies	323,900
Total	$2,252,400
Annual O&M Cost, all lagoons	$ 250,000

Pumping and Transmission Facilities - Construct facilities capable of transferring effluent from sewage treatment plants to holding ponds.

Assume the same facilities as proposed under the spray irrigation alternative:

Walnut Creek Plant.

PUMPS

Capital Cost	$ 350,000
Engineering & Contingencies	69,300
Total	$ 419,300
Annual O&M Cost	$ 350,000

TRANSMISSION LINES

Capital Cost	$2,100,000
Engineering & Contingencies	352,800
Total	$2,452,800
Annual O&M Cost	$ 42,000

Govalle Plant.

PUMPS

Capital Cost	$ 190,000
Engineering & Contingencies	38,500
Total	$ 228,500
Annual O&M Cost	$ 185,000

TRANSMISSION LINES

Capital Cost	$ 600,000
Engineering & Contingencies	109,200
Total	$ 709,200
Annual O&M Cost	$ 185,000

Onion Creek Plant.

PUMPS

Capital Cost	$ 150,000
Engineering & Contingencies	31,300
Total	$ 181,300
Annual O&M Cost	$ 140,000

TRANSMISSION LINES

Capital Cost	$ 564,000
Engineering & Contingencies	104,300
Total	$ 668,300
Annual O&M Cost	$ 11,300

Pumping and Transmission Facilities - Construct facilities capable of transferring effluent from the holding facilities to the spray field.

PUMP STATION
(91.2 mgd)

Capital Cost	$2,450,000
Engineering & Contingencies	409,100
Total	$2,859,100
Annual O&M Cost	$ 816,000

TRANSMISSION LINES

Capital Cost	$17,084,100
Engineering & Contingencies	2,716,300
Total	$19,800,400
Annual O&M Cost	$ 341,600

PART III

NON-METRO PLANS, CAPCO
(GENERAL)

Introduction.

The purpose of this portion of the report is to develop conceptual plans for each of the public wastewater treatment facilities in the non-metropolitan areas to meet the objectives of PL 92-500 by the most cost effective means. The non-metropolitan areas are divided into two categories: those cities and towns having existing treatment facilities or for which treatment facilities are proposed during the study period; and, the communities and special purpose districts adjacent to the Highland Lakes which either have existing treatment facilities or for which treatment facilities are proposed during the study period.

Most of the CAPCO region within the Colorado River Basin was covered in "The Highland Lakes System Comprehensive Wastewater Study 1970-1990," by Freese, Nichols and Endress, Inc., Consulting Engineers, December, 1970. This report, commonly referred to as the "Highland Lakes Report" was used extensively in preparing the non-metropolitan portion of this study, particularly with regard to existing sewage collection systems and population projections for the communities along the Highland Lakes. The design criteria proposed in the Highland Lakes Report was also generally used for the facilities proposed herein for those developed areas along the Highland Lakes.

Design Criteria.

Estimates for projected future average dry weather flows for the non-metropolitan areas are based on 100 gallons per capita per day and projected population. Determination of collection system pipe sizes for non-metropolitan areas adjacent to the Highland Lakes was based on a contribution factor of 400 gallons per person per day, which includes a multiplier of 3.25 for maximum dry weather flow plus an allowance of 75 gallons per capita per day for infiltration. Collection systems in all remaining non-metropolitan areas were sized using a design criteria of 2,000 gallons per acre per day.

All gravity sewer lines were sized based on a minimum flow velocity of 2.0 feet per second. Force mains were sized based on a minimum flow velocity of 2.5 feet per second and a maximum flow velocity of 5.0 feet per second. The maximum allowable total head on a lift or pump station for raw sewage was assumed to be 50 feet. In sizing proposed collection systems, the smallest gravity sewer shown is six-inch diameter. Because six-inch diameter lines have a higher occurance of clogging and, thus, require substantial maintenance, no single six-inch line any longer than 600 feet was utililzed.

NON-METRO PLANS, CAPCO
(AREAS ADJACENT TO THE HIGHLAND LAKES)

Many of the homes adjacent to the Highland Lakes are not permanent homes but are second homes occupied during weekends, summer months, or for vacations. In considering the economic justification for people moving into the communities along the lakes, it is not because people are attracted by job opportunities but by an attractive area for recreation and retirement. Service jobs will develop due to the increasing population moving into the area which will be supported by incomes not dependent upon local jobs. Light commercial development is already following the existing residential development in the lakeside communities in the form of service stations, grocery stores, restaurants, marina and sporting goods establishments, and motels.

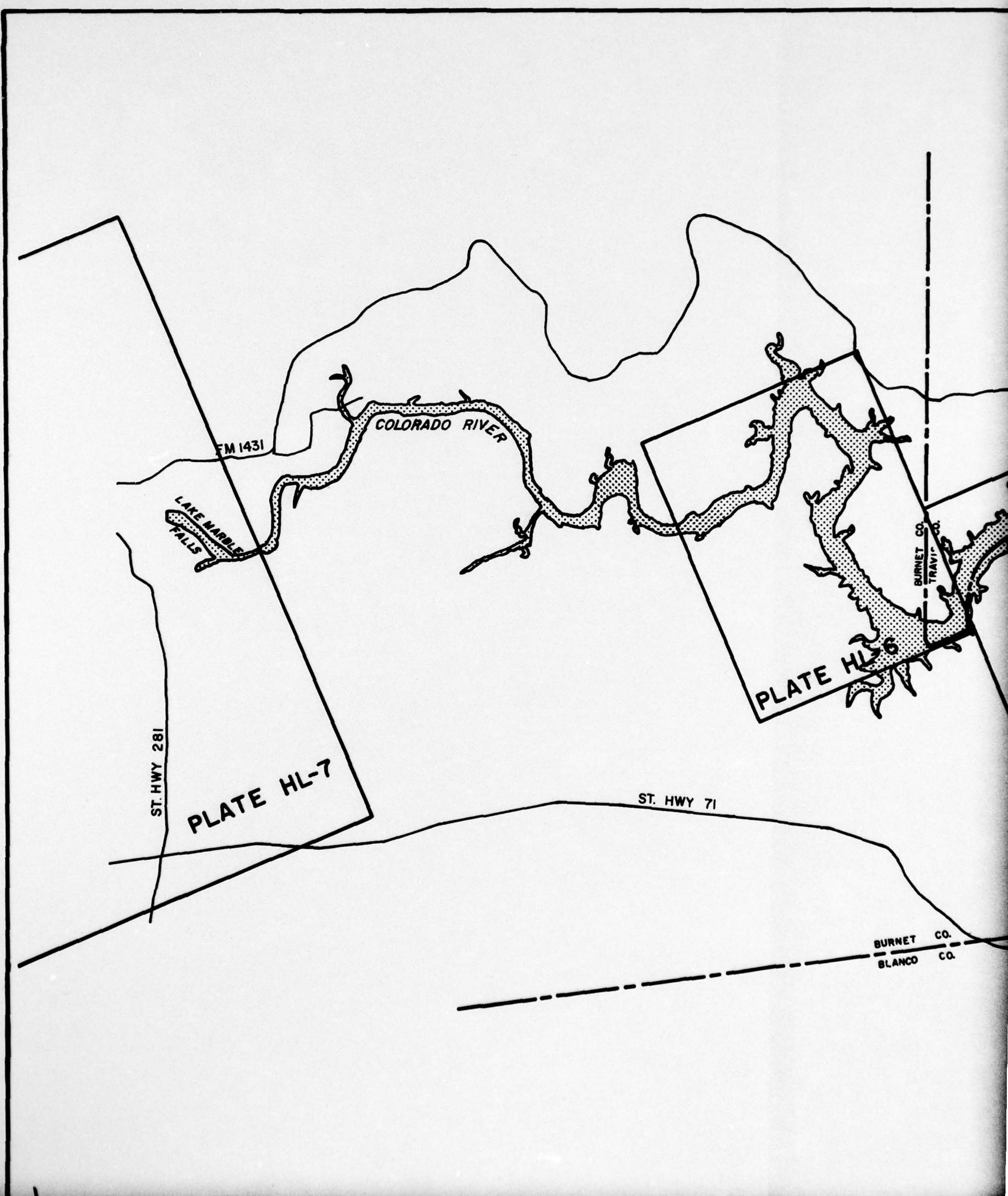
The Phase I section of the Highland Lakes Report presents an estimate of the number of homes along the lakes along with a projection of the number of temporary and permanent residents through year 1990. This information is presented at the beginning of the discussion for each lake.

The Highland Lakes chain is shown on Plates HL-A, B, and C. These plates serve as vicinity maps for locating communities and special purpose districts along the lakes. The development from Lake Travis to Lake Buchanan is covered on a series of 14 plates prepared from USGS 7-1/2 - minute quadrangle sheets, having a scale of one inch = 2,000 feet. To find the location of a particular development, it is first located on one of the vicinity maps from which the correct plate number is obtained. The area of interest is then located on the proper plate. The developments for which facilities are either existing and/or proposed are also listed in the Table of Contents. If an area of development does not have a proper name (community, township, special purpose district, etc.) it is listed herein with reference to a river bend, creek, or roadway as given on the USGS quadrangle maps.

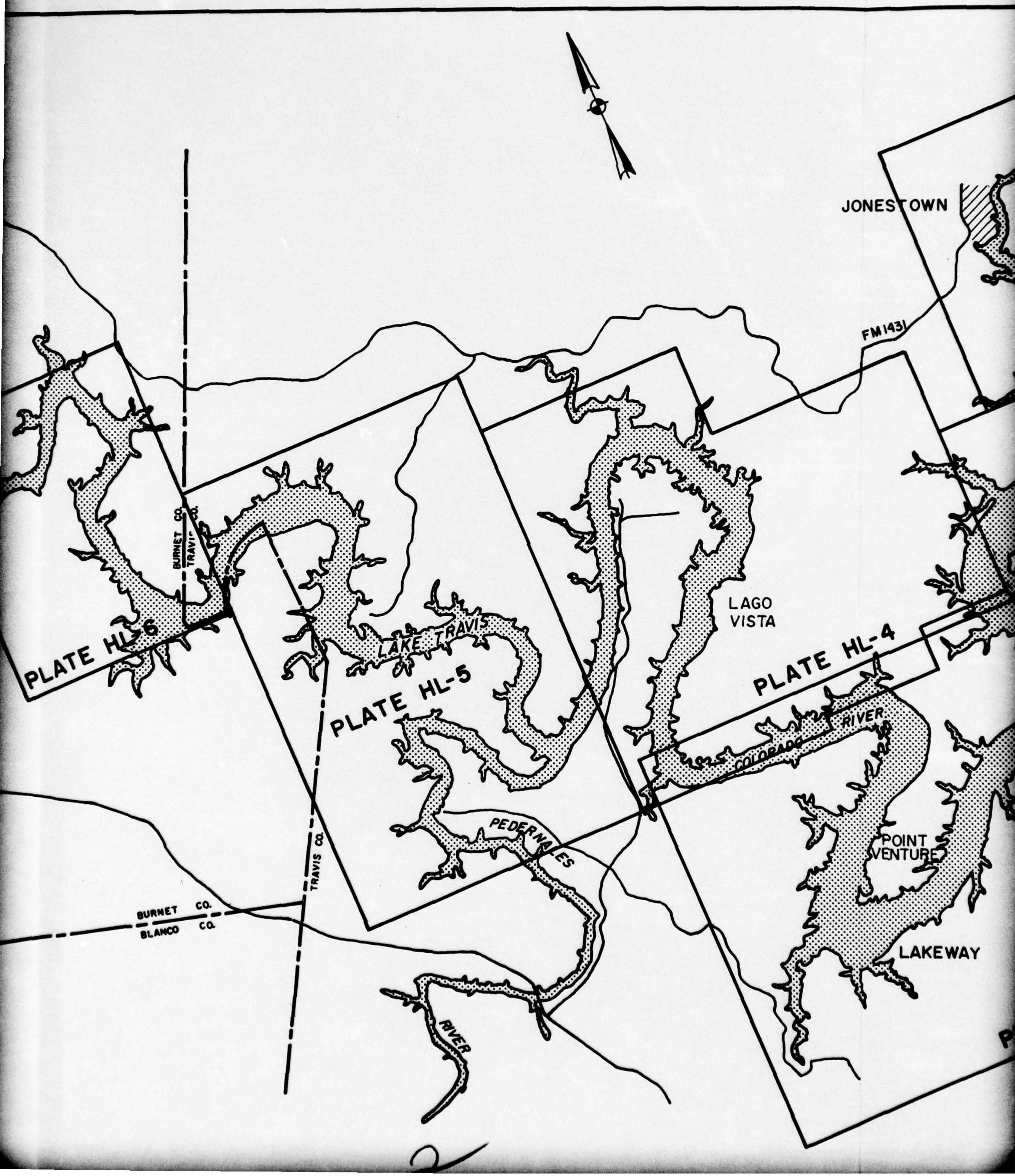
The non-metropolitan communities adjacent to the Highland Lakes are discussed with respect to the particular plate on which they are located and also with respect to the particular lake which they are adjacent to. The discussions begin with Plate I, which covers the lower Lake Travis area including Mansfield Dam and proceed upstream through Plate 14, which covers a portion of the upper part of Lake Buchanan. The entire shoreline area of all the lakes is not covered by the 14 plates since there are areas where development is either non-existent or very scattered and for which there is no proposed development at this time.

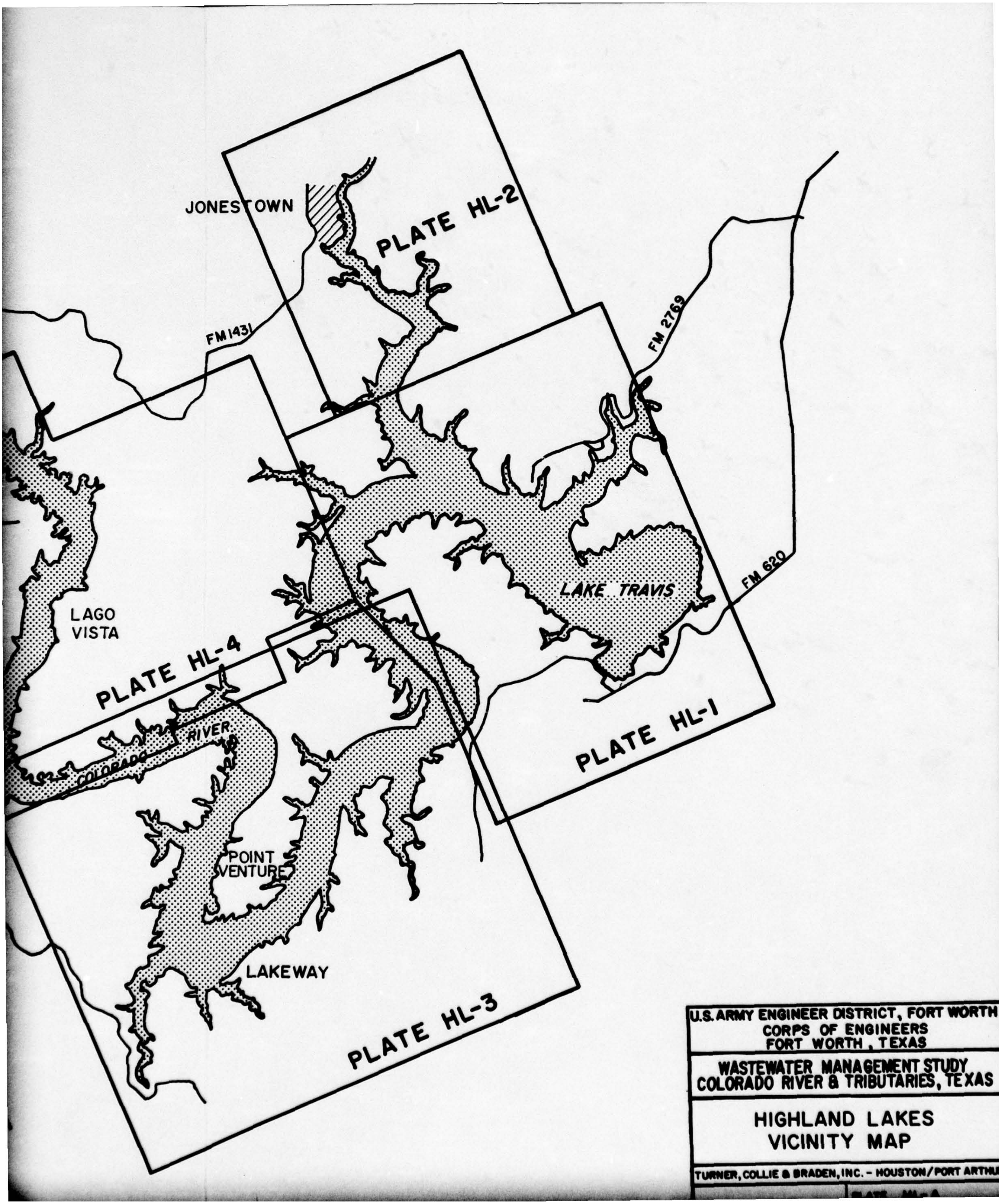
The discussions and exhibits for the non-metropolitan areas adjacent to the lakes include proposed sewage collection and treatment facilities based on population projections presented for each area. The collection systems

proposed for some of the areas would serve throughout the study period, with future development assumed to occur within existing scattered development, while for other areas, the collection systems are proposed in phases where future development is expected to occur within existing development as well as into new areas which are presently uninhabited. The capacities of the proposed sewage treatment facilities are based entirely on population projections. Phasing of increments in treatment capacity is dependent upon the existing population and the amount of increase in population expected over the study period through year 2020. For example, if a community is expected to have little increase in population by 2020, one capacity of sewage treatment would be proposed to serve throughout the study period. If an area is projected for a moderate or larger increase in population, an initial capacity of sewage treatment is proposed with an expansion to these facilities phased at a later date to serve the projected population.



COLORADO RIVER
FM 1431
LAKE MARBLE FALLS
PLATE HL-7
ST. HWY 281
ST. HWY 71
PLATE HL-6
BURNET CO.
TRAVI
BURNET CO.
BLANCO CO.


JONESTOWN
FM 1431
BURNET CO.
TRAVIS
PLATE HL-6
LAKE TRAVIS
PLATE HL-5
LAGO
VISTA
PLATE HL-4
COLORADO
RIVER
PEDERNALES
POINT
VENTURE
LAKEWAY
TRAVIS CO.
BURNET CO.
BLANCO CO.
RIVER



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FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
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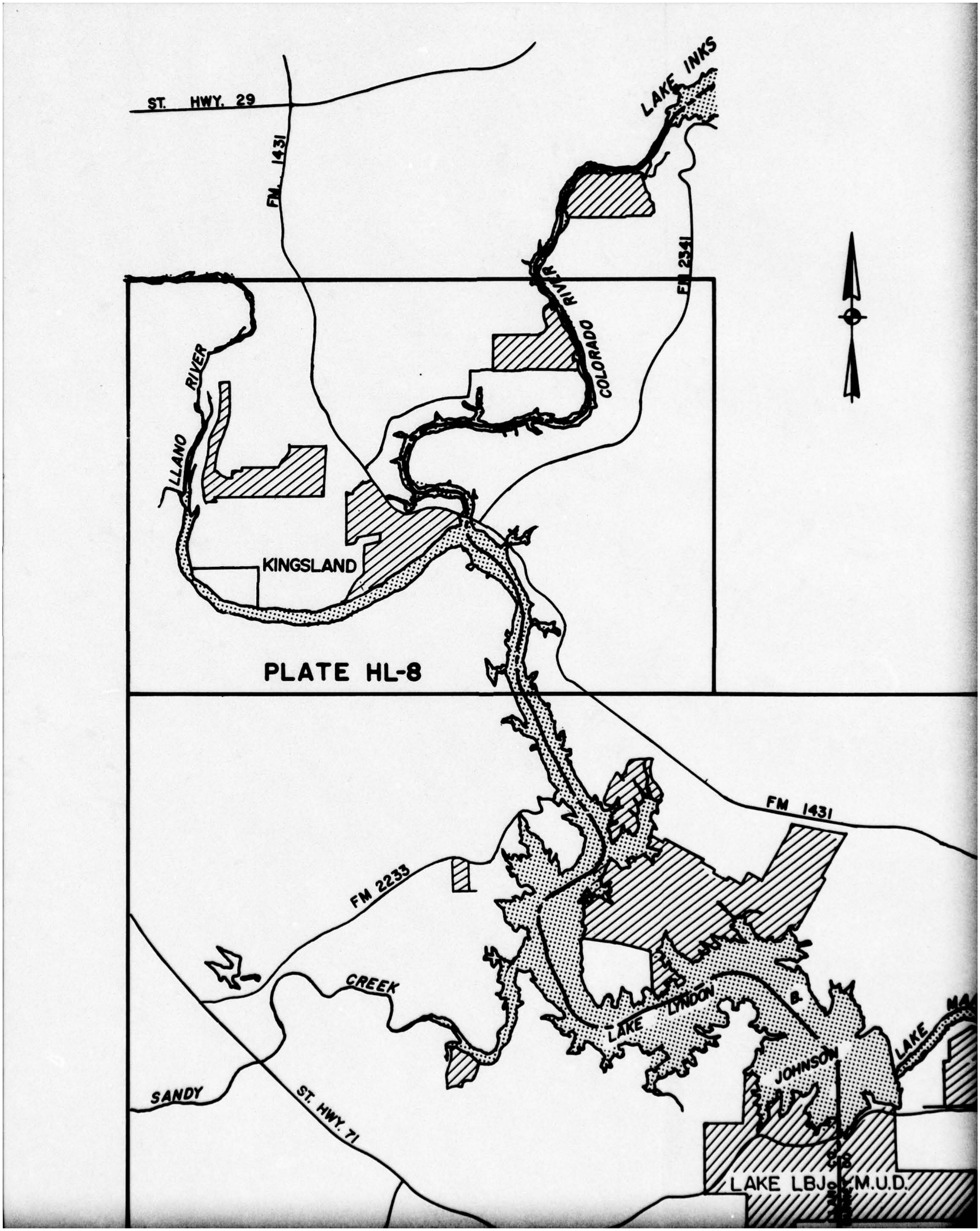
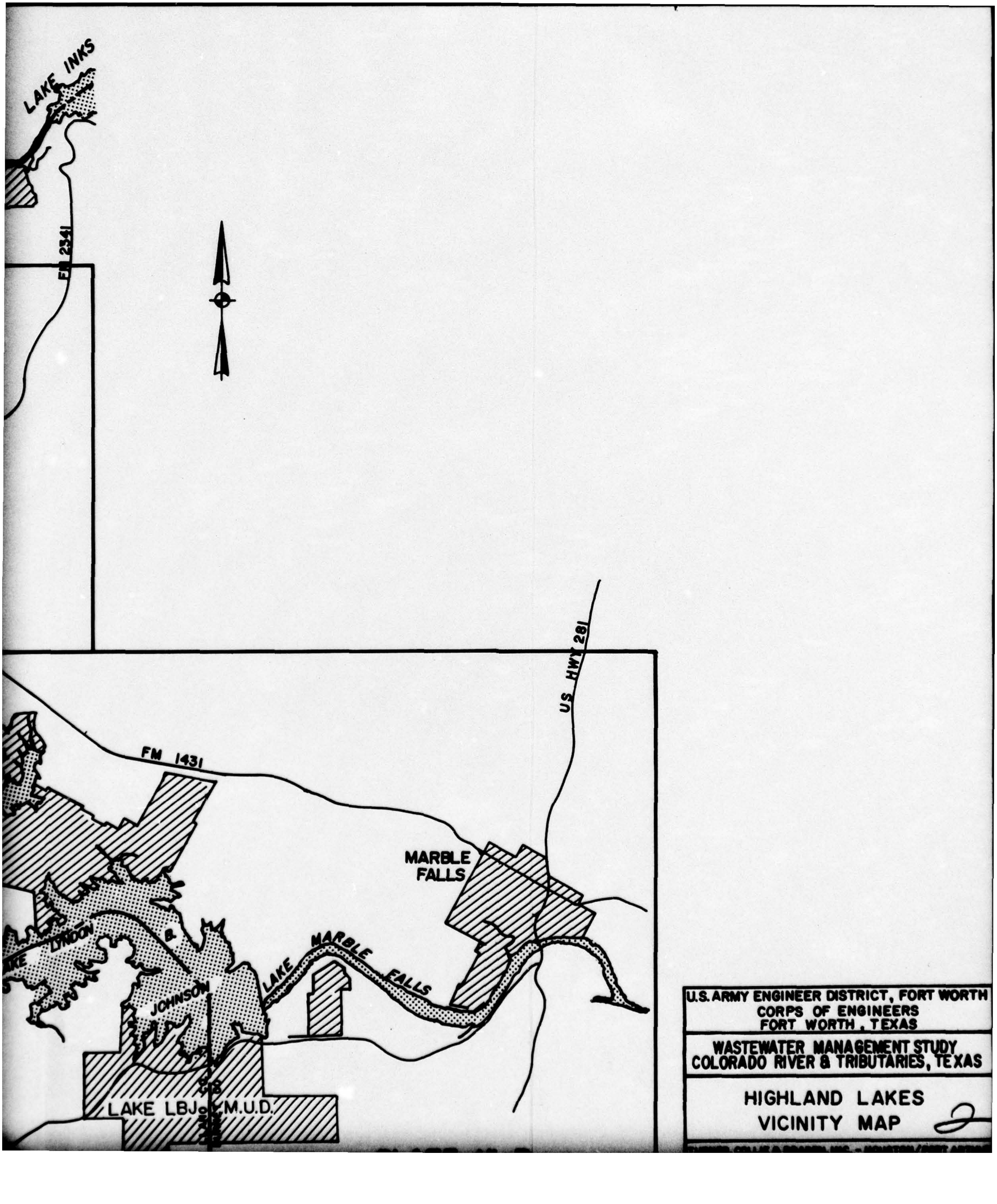
HIGHLAND LAKES
VICINITY MAP

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHU



ST. HWY. 29
FM 1431
LAKE INKS
FM 2341
COLORADO RIVER
LLANO RIVER
KINGSLAND
PLATE HL-8
FM 1431
FM 2233
CREEK
SANDY
ST. HWY. 71
LAKE LYNDON B. JOHNSON
LAKE LBJ M.U.D.



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FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

HIGHLAND LAKES
VICINITY MAP

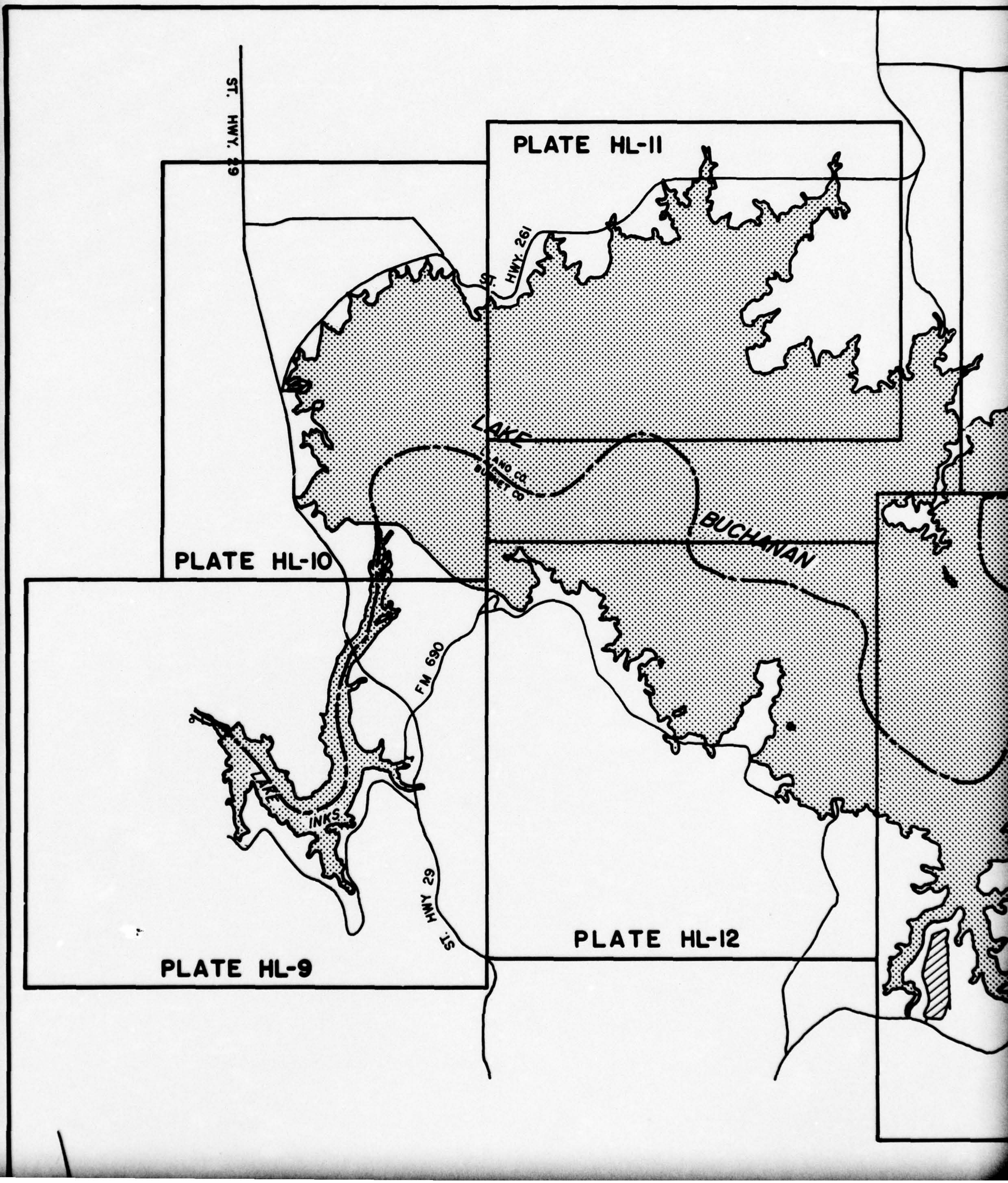
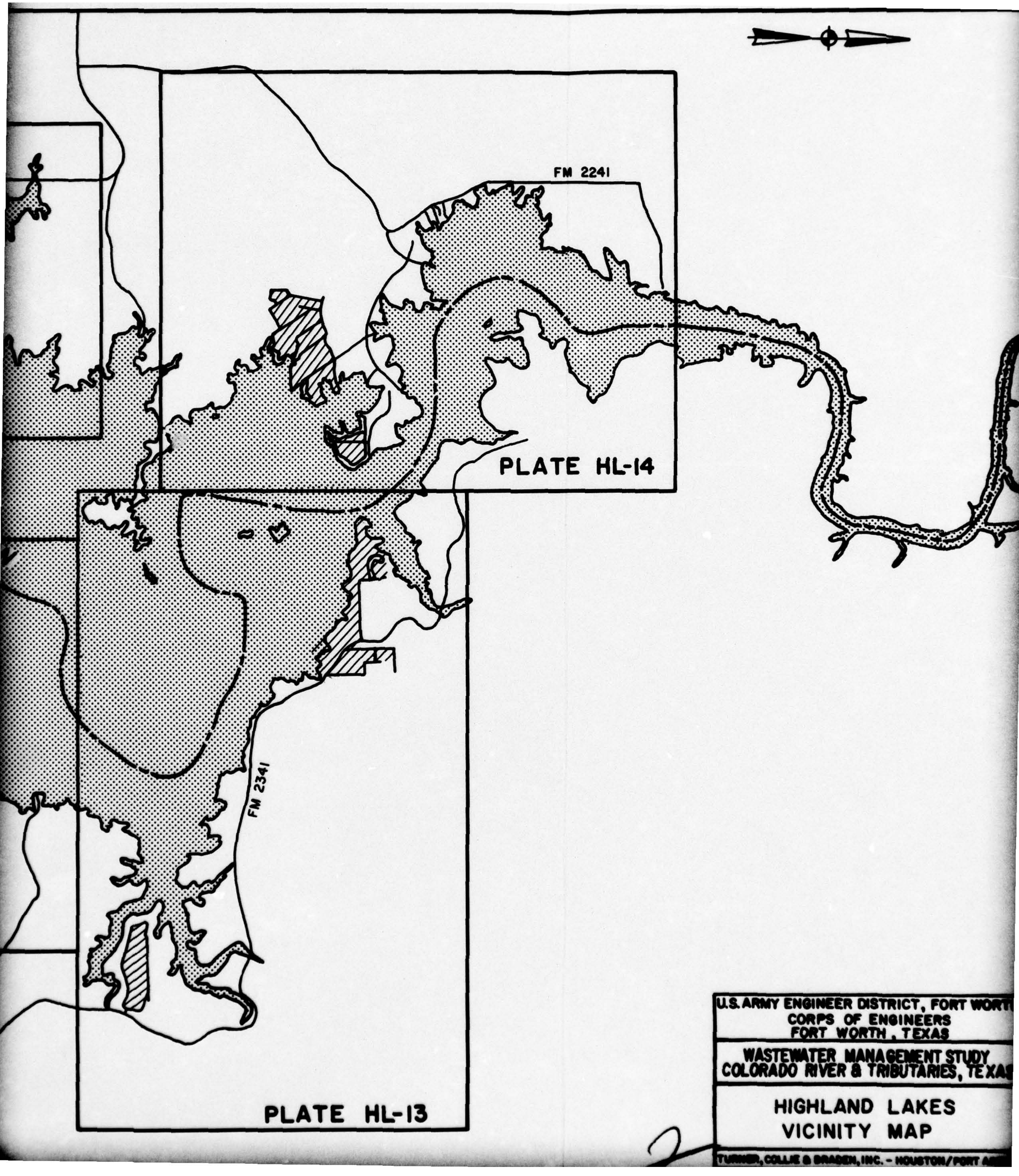


PLATE HL-11
PLATE HL-10
PLATE HL-9
PLATE HL-12
ST. HWY. 29
ST. HWY. 261
LAKE BUCHANAN
LLANO CO.
BURNET CO.
FM 690
LAKE INKS
ST. HWY 29



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WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

HIGHLAND LAKES
VICINITY MAP

TURNER, COLLIE & BRADEN, INC. - HOUSTON/FORT A

Lake Travis Area
(Plates HL-1 through HL-7)

Introduction.

The number of houses by permanent and temporary categories adjacent to Lake Travis from 1970 projected through year 1990, as given in the Highland Lakes Report, are shown below.

	Number of Houses				
	1970	1975	1980	1985	1990
Lake Travis-North Side	1354	1722	2090	2458	2826
Permanent	722	1068	1400	1770	2176
Temporary	582	654	690	688	650
Lake Travis-South Side	944	1212	1480	1749	2017
Permanent	467	654	903	1207	1553
Temporary	477	558	577	542	464

The table indicates that the trend is toward a larger portion of permanent homes than temporary. This projection would seem valid, especially with respect to the larger commercially developed areas such as Lakeway, Lago Vista, and Point Venture since these areas are attracting more retired people who are making their permanent homes in these areas. The older, smaller lakeside communities will probably retain a larger number of the temporary type homes over permanent ones.

The soils surrounding Lake Travis consist entirely of the Brackett-Tarrant general series. This type of soils is characterized by calcareous clays, grayish brown to light brown, with numerous fragments of limestone. They range from 3 to 8 inches thick and are generally underlain by broken or partly weathered limestone or limestone bedrock at less than 12 inches beneath the surface. The slopes generally range from 5 to 30 percent although very steep cliffs and deep ravines are found adjacent to the lake.

The permeability of these soils range from 0.20 to 0.63 inches per hour. The soils are reported as being poor and severely limiting with respect to most general engineering properties including source of topsoil, highway location, foundations for low buildings, septic tank filter fields, sewage lagoons, and farm ponds.

This soil type and terrain would lend themselves only to the overland runoff method of land disposal with reference to the recommended guidelines set

forth in the following reports: (1) "Assessment of the Effectiveness of Land Disposal Methodologies of Wastewater Management," Department of the Army Corps of Engineers, Wastewater Management Report 72-1, January, 1972, and (2) "Wastewater Management by Disposal on the Land," Special Report 171, CFREL, Department of the Army Corps of Engineers, May, 1972. A soil thickness of 6 to 8 inches is recommended, being fairly impervious (0.2 inches per hour permeability) and having a slope ranging from 2 to 6 percent. Although in most areas the slope requirement is limited, the land application of effluent which currently exists in several of the large developments is practiced on golf courses which have been specially designed and constructed to meet the above requirements. However, in the smaller communities and developments there are no golf courses existing or proposed which would provide the necessary amount and type of land. For these areas, tertiary treatment by means of filtration is proposed. It should be noted that upon construction of sewage treatment and collection facilities in these areas, if suitable land sites are available for land disposal of the effluent on a permanent basis, this type of treatment may be substituted for filtration by these communities.

Water supply in the areas around the lake consists of both Lake Travis and individual wells. Many of the communities are served by private water companies or by special purpose district water plants that treat water from Lake Travis. There are also a number of private wells, especially in the areas where development is more scattered.

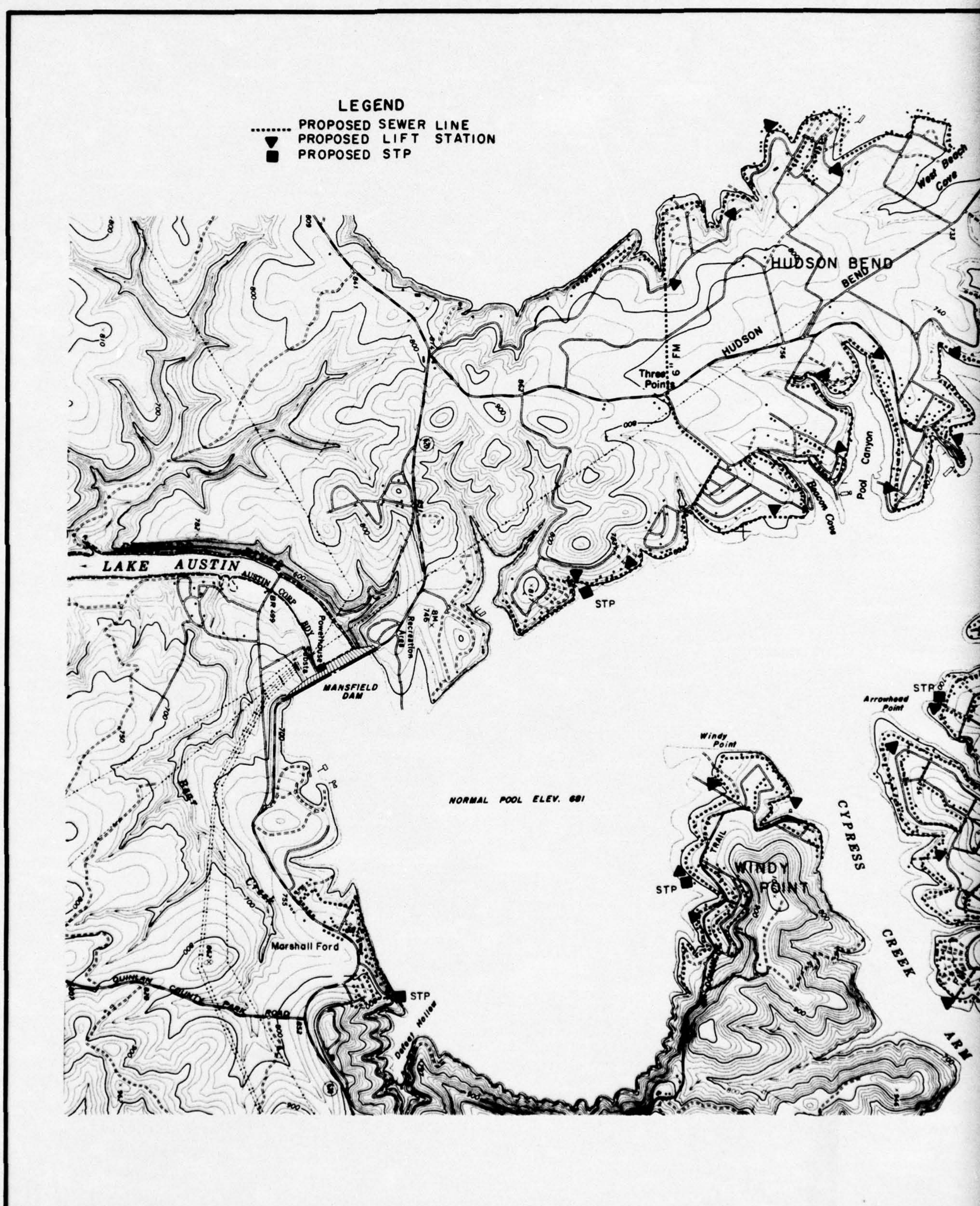
Marshall Ford Area.

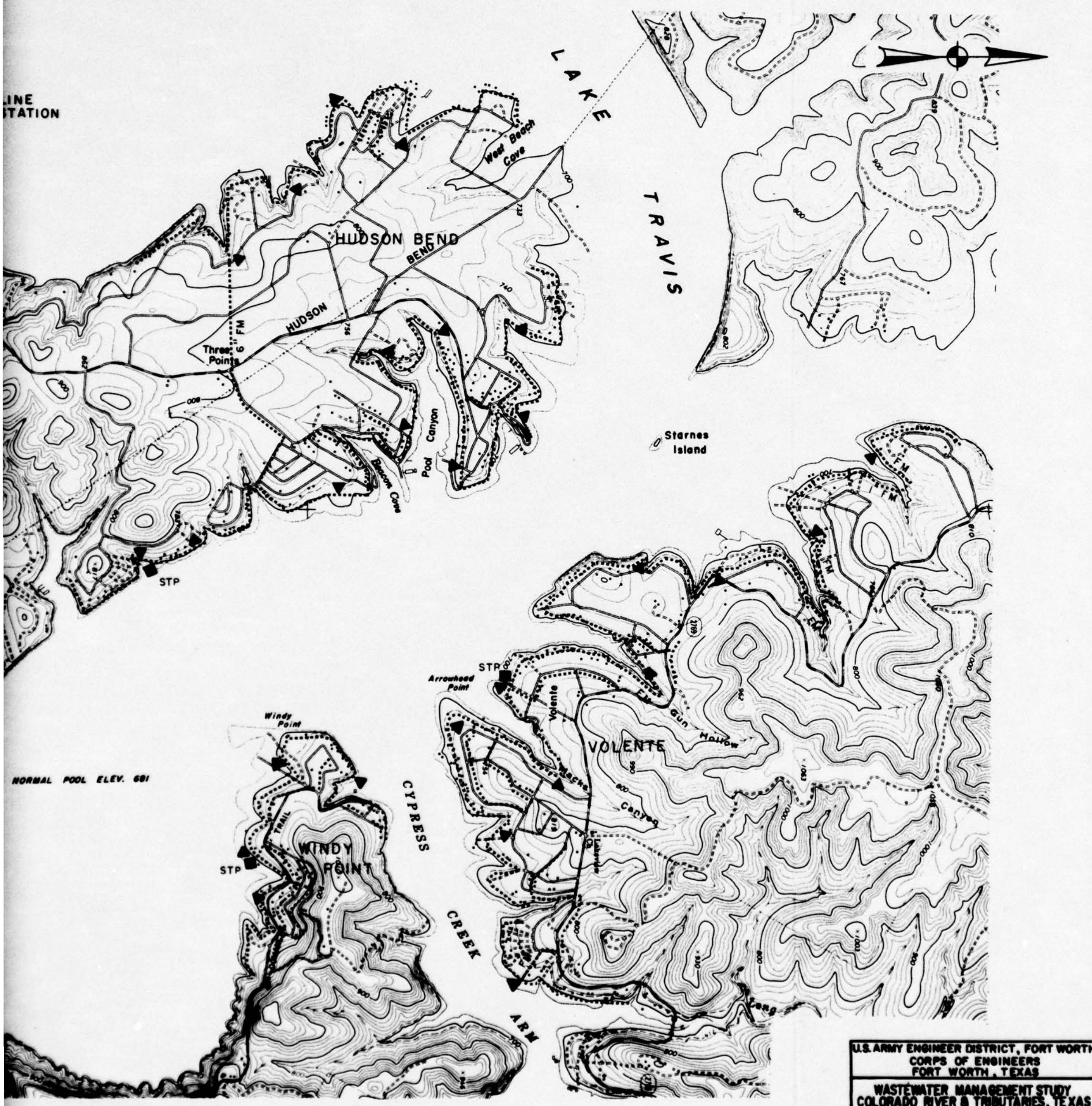
This unincorporated area consists of about 40 houses located approximately 6,000 feet east of Mansfield Dam. This area was designated as Area 16 in the Phase III Highland Lakes Report under Plan A, Sub-Area 3. The population projections for the Marshall Ford area, as given in the Highland Lakes Report through year 1990, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	182	350	490	700	1,100

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system as shown on Plate HL-1 be constructed by 1975. It is also proposed that a secondary treatment facility and filtration plant be constructed at that time, both having an initial design capacity of 0.055 mgd. The cost of the proposed collection system, including a lift station and engineering and contingencies, is estimated to be $136,100. The cost of the 0.055 mgd secondary treatment and filtration facilities is estimated to be $97,600. This design capacity would be adequate until about 1984. By 1983 nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $126,500.


LEGEND
PROPOSED SEWER LINE
PROPOSED LIFT STATION
PROPOSED STP
HUDSON BEND
West Beach Cove
HUDSON
BEND
Three Points
FM
Pool Canyon
Beacon Cove
LAKE AUSTIN
AUSTIN CORP
STP
Powerhouse
Recreation
MANSFIELD DAM
NORMAL POOL ELEV. 681
Windy Point
WINDY POINT
TRAIL
CYPRESS
CREEK
ARM
Arrowhead Point
Marshall Ford
Creek
Defeat Hollow



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COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE TRAVIS

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SCALE 1" = 3000' | PLATE HL-1

2

To meet the wastewater treatment requirements for an increasing population, a 0.055 mgd expansion of the facilities would be required by 1984, and would be adequate until the year 2020. The estimated cost for this 0.055 mgd expansion of only the secondary treatment and filtration facilities would be $98,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Marshall Ford area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.055 mgd conventional secondary treatment facility of the contact-stabilization type at an approximate capital cost of $79,600 including engineering and contingencies.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $50,000.

This no-discharge plan would require phased capacity expansion as presented in the discharge plan.

Windy Point Area.

The Windy Point area is located on the north shore of Lake Travis about 9,000 feet northeast of Mansfield Dam. The 1970 population was estimated to be 494 in the Phase III Highland Lakes Report under Area 15 Plan A, Sub-Area 3. The population projections presented below show the area is expected to reach 1,750 by 1,990, and 2,500 by year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	494	945	1,225	1,750	2,500

Based on the above population projections, it is recommended that the proposed collection system shown on Plate HL-1 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $334,800. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.15 mgd. The cost of the 0.15 mgd secondary treatment and filtration facilities is estimated to be $190,700. This design capacity would be adequate until about 1985. By 1983 nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $180,000.

To meet the wastewater treatment requirements for an increasing population, a 0.050 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 1995. The estimated cost for this

0.050 mgd expansion of only the secondary treatment and filtration facilities and lift station would be $126,500. An additional 0.050 mgd expansion would be required by 1995, with an estimated cost for only the secondary treatment and filtration facilities and lift station of $122,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Windy Point area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.15 mgd conventional secondary treatment facility at an approximate capital cost of $157,500, including engineering and contingencies.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $130,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Volente Area

The Volente area is located on the north side of Lake Travis across the Cypress Creek Arm from Windy Point. The area consists of Areas 9, 10, 11, 12, 13, and 14 in the Phase III section of the Highland Lakes Report under Plan A, Sub-Area 3. The population projections through 1990, as given in the Highland Lake Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	1,261	1,698	2,257	2,870	3,500

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system as shown on Plate HL-1 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $948,200. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.26 mgd. The cost of the 0.26 mgd secondary treatment and filtration facilities is estimated to be $276,000. By 1983 nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $ 24,000.

To meet the wastewater treatment requirements for an increasing population, a 0.090 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.090 mgd expansion of only the secondary treatment and filtration facilities and lift station would be $232,600.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Volente area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.26 mgd conventional secondary treatment facility at an approximate capital cost of $228,200, including engineering and contingencies.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $240,000.

This no-discharge plan would require phased capacity expansion as presented in the discharge plan.

Hudson Bend Area.

The Hudson Bend area is located on the south side of Lake Travis approximately 13,000 feet north of Mansfield Dam. This area consists of Areas 17, 18, and 19 in the Phase III section of the Highland Lakes Report under Plan A, Sub-Area 3. The population projections through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	921	988	1,061	1,365	2,200

Based on the above population projections, it is recommended that the proposed collection system as shown on Plate HL-1 to be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $975,600. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.12 mgd. The cost of the 0.12 mgd secondary treatment and filtration facilities is estimated to be $162,500. This design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $169,800.

To meet the wastewater treatment requirements for an increasing population, a 0.10 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.10 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $245,900.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Hudson Bend area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.12 mgd conventional secondary treatment facility at an approximate capital cost of $133,800, including engineering and contingencies.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $105,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Jonestown Area.

The Jonestown area is located along the western shore of the Sandy Creek Arm of Lake Travis. Jonestown was listed as Area 7 in the Phase III section of the Highland Lakes Report under Plan A, Sub-Area 3. The population projections for Jonestown through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

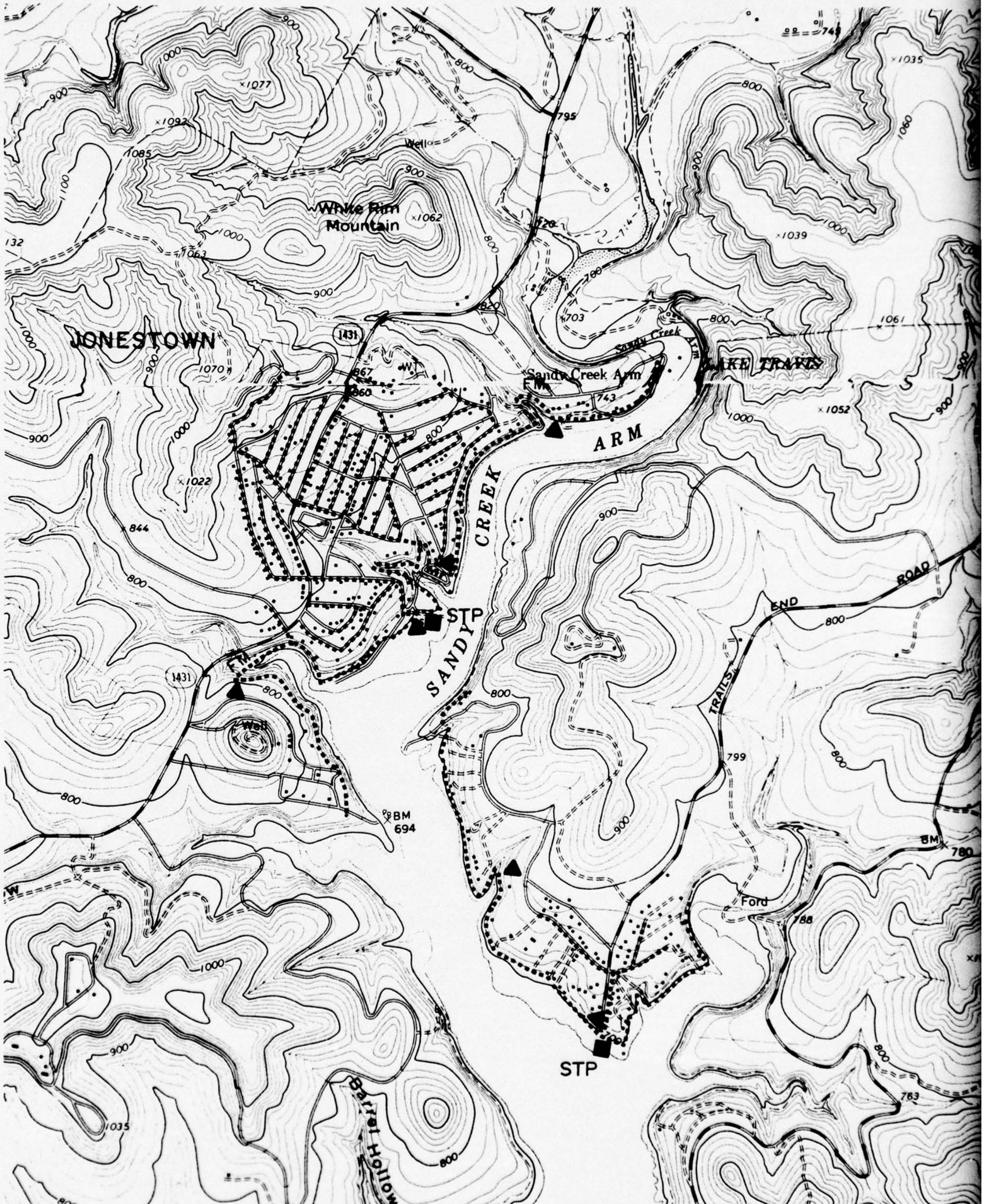
Year	1970	1975	1980	1990	2020
Population	1,194	1,225	1,383	1,645	2,000

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system as shown on Plate HL-2 be constructed by 1975. The cost of the proposed collection system, including a lift station and engineering and contingencies, is estimated to be $663,600. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.15 mgd. The cost of the 0.15 mgd secondary treatment and filtration facilities is estimated to be $191,000. This design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $180,000.

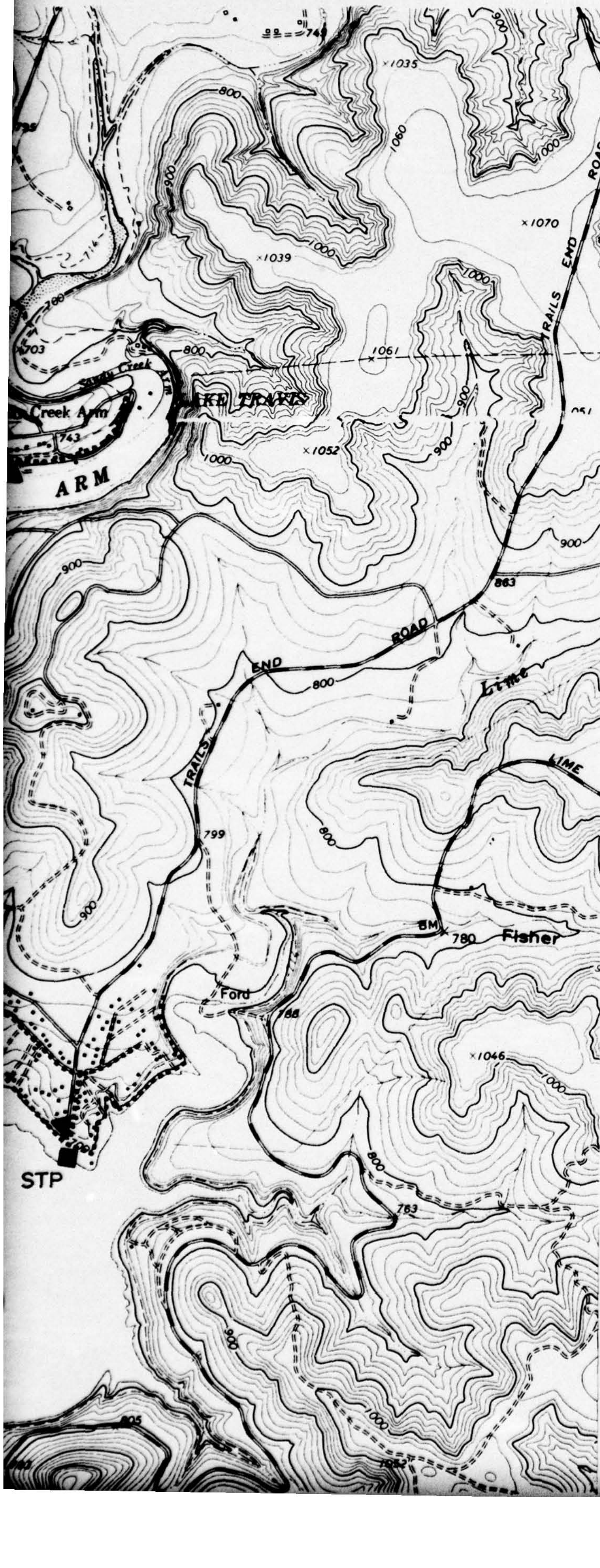
To meet the wastewater treatment requirements for an increasing population, a 0.05 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.05 mgd expansion of only the secondary treatment and filtration facilities would be $90,400. The cost of collection system improvements in 1985 is estimated to be $31,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Jonestown area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.15 mgd conventional secondary treatment facility at an approximate capital cost of $157,500, including engineering and contingencies.



JONESTOWN
White Rim Mountain
Sandy Creek Arm
LAKE TRAVIS
SANDY CREEK ARM
STP
STP
Barrel Hollow
TRAILS END ROAD
Ford
Well
BM 694
BM 780
1431
1431



LEGEND

- - - - PROPOSED SEWER LINE

▲ PROPOSED LIFT STATION

■ PROPOSED STP

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2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $130,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Trails End Road Area.

This area is located on the east side of Sandy Creek Arm across from and southeast of Jonestown. The Trails End Road community was listed as Area 8 in Phase III of the Highland Lakes Report under Plan A, Sub-Area 3. The population projections for this area through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	420	445	462	525	700

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-2 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $204,200. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.05 mgd. The cost of the 0.05 mgd secondary treatment facility and filtration plant is estimated to be $90,500. This initial design capacity would be adequate until about 1987. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $121,000.

To meet the wastewater treatment requirements for an increasing population, a 0.02 mgd expansion of the facilities would be required by 1987, and would be adequate until the year 2020. The estimated cost for this 0.02 mgd expansion of only the secondary treatment and filtration facilities and collection system would be $72,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Trails End Road area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.05 mgd conventional secondary treatment facility at an approximate capital cost of $73,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $44,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Buffalo Gap Area.

The Buffalo Gap area was presented as Area 20 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are shown below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	228	245	263	371	600

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-3 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $135,900. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.03 mgd. The cost of the 0.03 mgd secondary treatment facility and filtration plant is estimated to be $72,300. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $104,400.

To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $97,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Buffalo Gap Area wish to implement a no-discharge plan, the following items would be required:

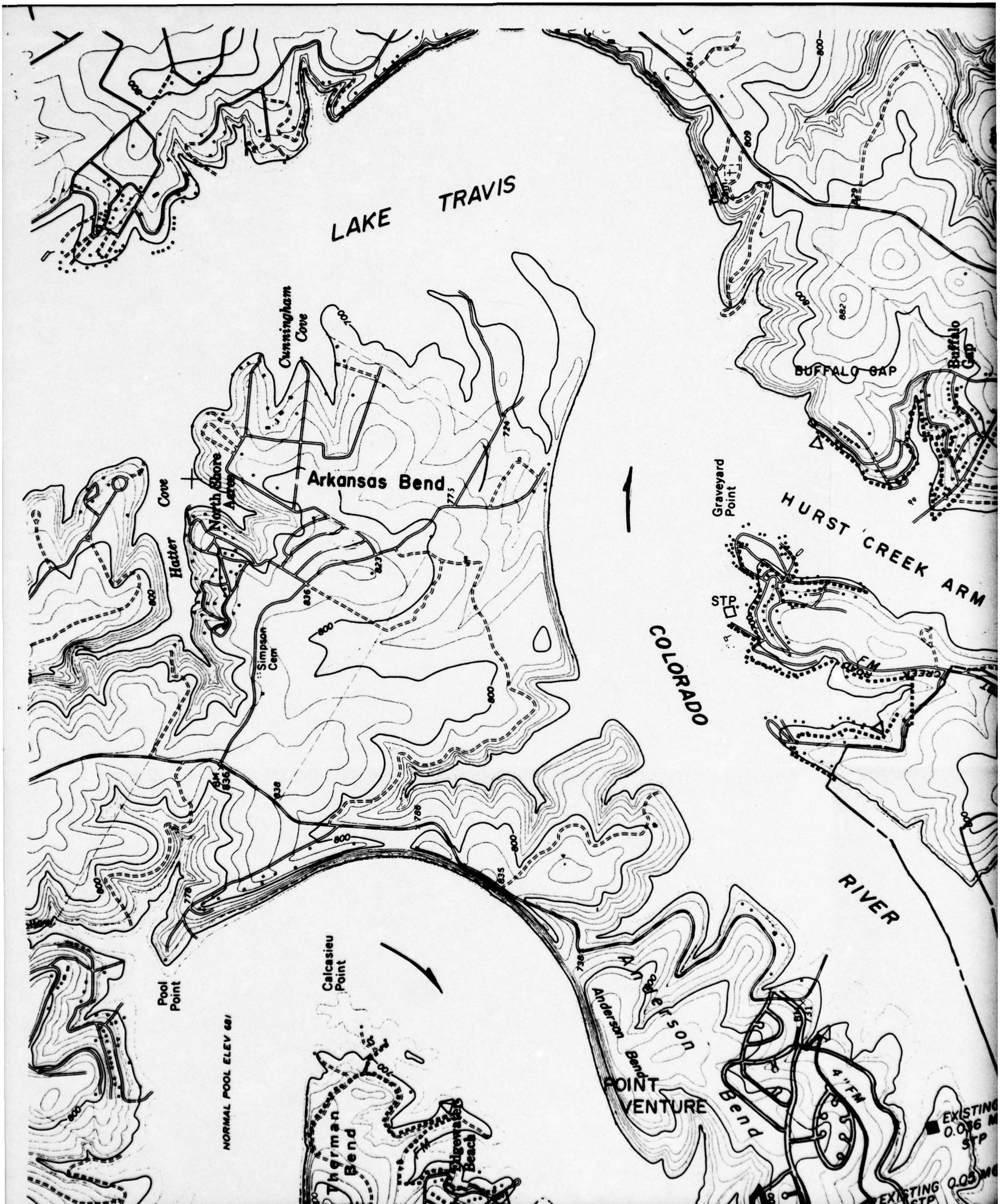
1. By 1977, construct a 0.03 mgd conventional secondary treatment facility at an approximate capital cost of $55,400.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $27,500.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

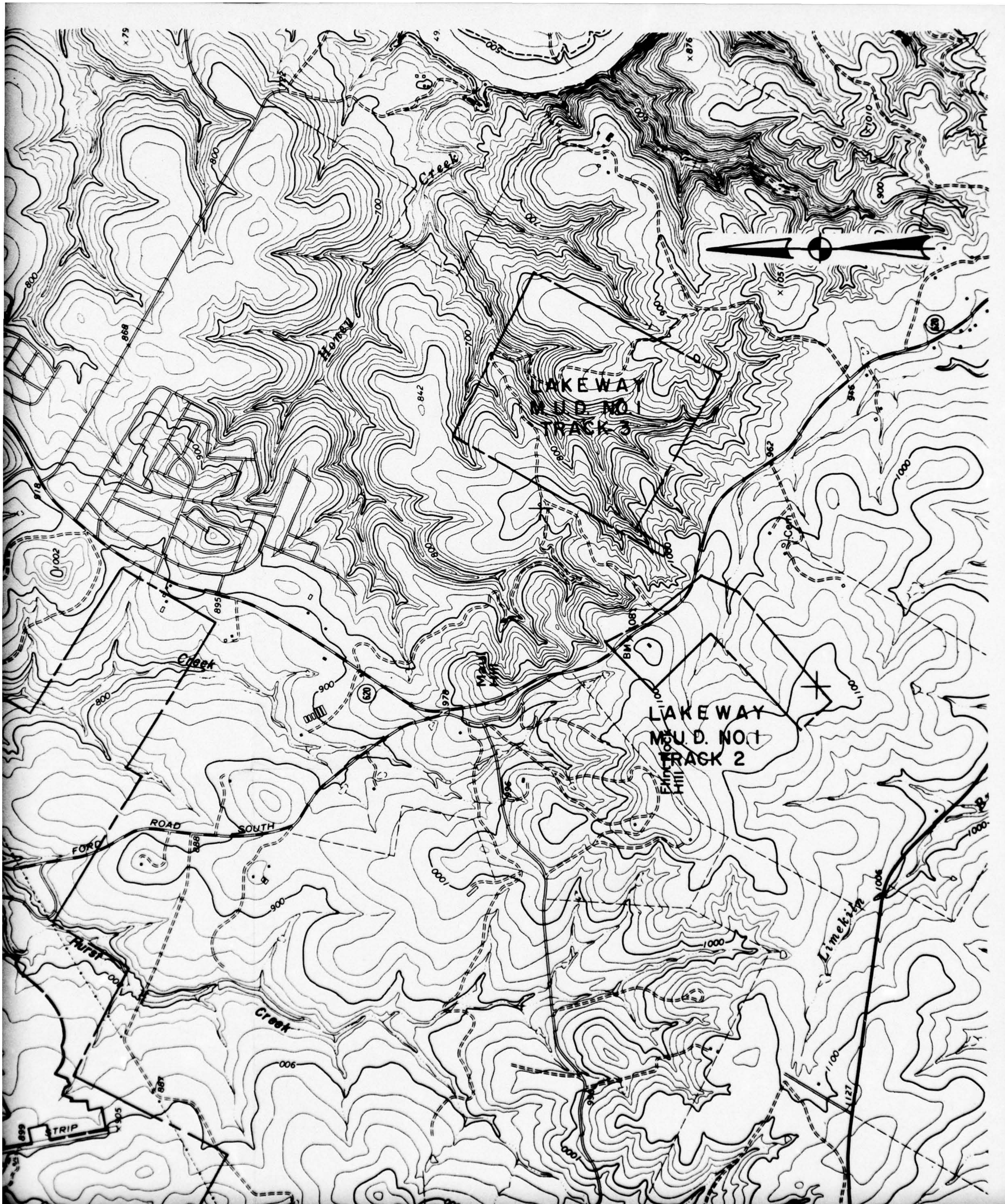
Hurst Creek Arm Area.

The Hurst Creek Arm area is located between the Hurst Creek Arm of Lake Travis and the Lakeway MUD No. 1. This area was presented as Areas 21 and 22 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections through 1990, as given

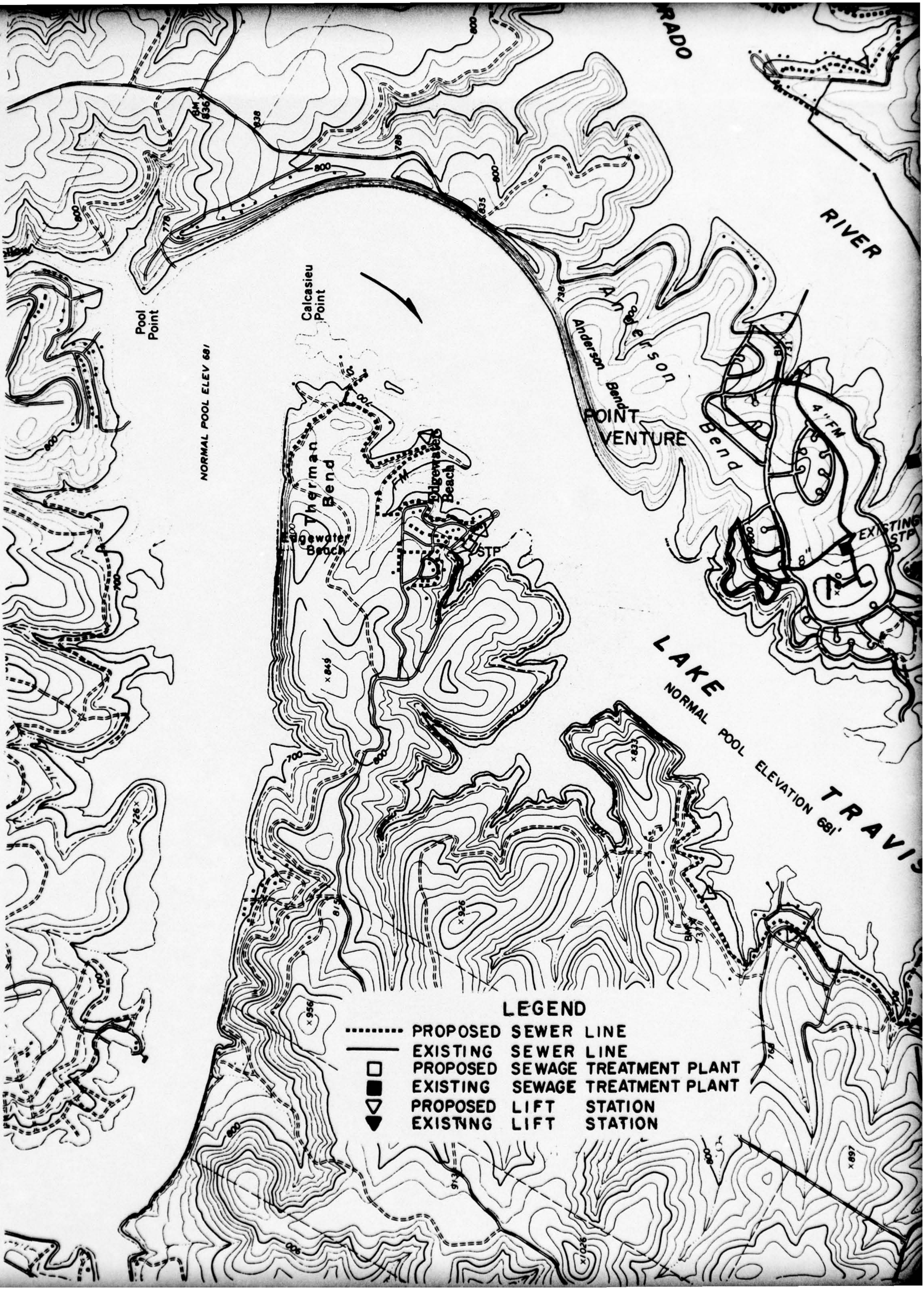


LAKE TRAVIS
Cunningham Cove
Arkansas Bend
North Shore Acres
Hatter Cove
Simpson Cem
Graveyard Point
BUFFALO GAP
Buffalo Gap
HURST CREEK ARM
STP
COLORADO
RIVER
Pool Point
Calcasieu Point
NORMAL POOL ELEV 681
Anderson
Anderson Bend
POINT VENTURE
Bend
Thurman Bend
Edgewater Beach
4"FM
EXISTING
STP

BUFFALO GAP
Buffalo Gap
Water Tank
F.M. 620
Round Mountain
HURST CREEK ARM
FM ROAD
HURST CREEK
Yaupon
Creek
Honey
LOHMANN FORD ROAD SOUTH
RIVER
Golf Course
Hurst
Creek
Lakeway
LANDING STRIP
EXISTING 0.036 MGD STP
EXISTING 0.05 MGD STP
4"FM

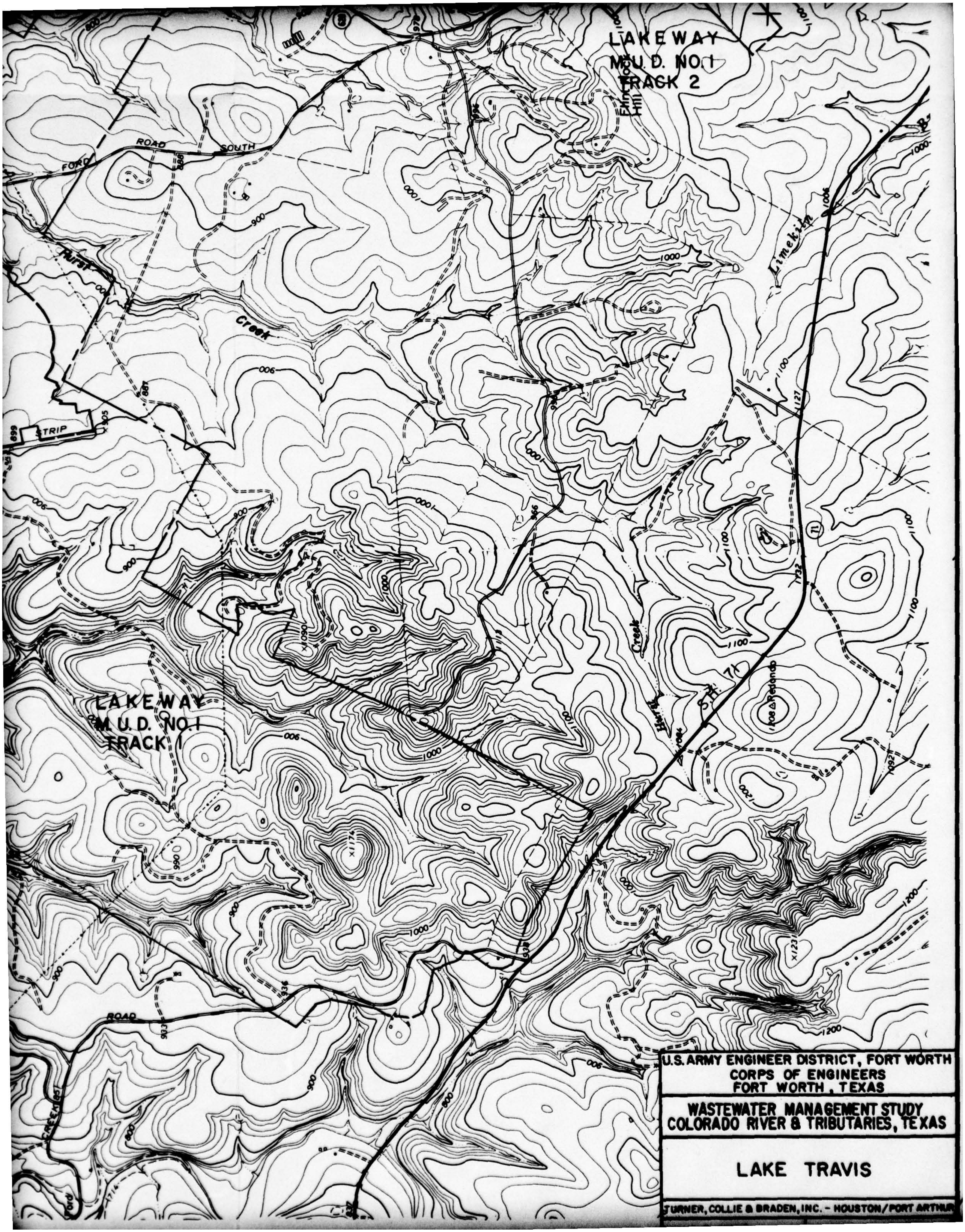


LAKEWAY
M.U.D. NO. 1
TRACK 3
LAKEWAY
M.U.D. NO. 1
TRACK 2
Honey
Creek
Creek
Hurst
Creek
Limekiln
FORD
ROAD
SOUTH
STRIP
Flintrock
Hill



COLORADO RIVER
LAKE TRAVIS
NORMAL POOL ELEVATION 681'
NORMAL POOL ELEV 681
Pool Point
Calcasieu Point
Anderson Bend
POINT VENTURE
Therman Bend
Edgewater Beach
STP
4" FM
8"
EXISTING STP
LEGEND
PROPOSED SEWER LINE
EXISTING SEWER LINE
PROPOSED SEWAGE TREATMENT PLANT
EXISTING SEWAGE TREATMENT PLANT
PROPOSED LIFT STATION
EXISTING LIFT STATION

RIVER
LAKE TRAVIS
NORMAL POOL ELEVATION 681'
Bend
4"FM
8"
EXISTING 0.036 MGD STP
EXISTING 0.05 MGD STP
Golf Course
Lakeway
LANDING STRIP
LOHMANN FORD ROAD SOUTH
Hurst Creek
LAKEWAY M.U.D. NO. I TRACK I
STP
ENT PLANT
ENT PLANT
BEE CREEK
BEE CREEK ROAD
ROAD


LAKEWAY
M.U.D. NO. I
TRACK 2
LAKEWAY
M.U.D. NO. I
TRACK 1
FORD ROAD SOUTH
Hurst Creek
Limekiln
STRIP
S.H. 71
Redondo
ROAD
CREEK
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FORT WORTH, TEXAS
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COLORADO RIVER & TRIBUTARIES, TEXAS
LAKE TRAVIS
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in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	301	333	378	515	570

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-3 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $210,100. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.06 mgd. The cost of the 0.06 mgd secondary treatment facility and filtration plant is estimated to be $103,700. This initial design capacity would be adequate throughout the study period. By 1973, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $131,800.

As an alternative for separate wastewater treatment facilities for the Hurst Creek Arm area, a contractual agreement could be made with the Lakeway MUD No. 1 whereby wastewater from the Hurst Creek Arm area would be treated at the subregional plant proposed for Lakeway. The cost for this alternative, including a collection system, lift stations, force main to subregional plant and engineering and contingencies, is estimated to be $278,900. This alternative could, therefore, be considered as a no-discharge plan for the Hurst Creek Arm area.

Bee Creek - East Area.

The area is located adjacent to Bee Creek and the south shore of Lake Travis between Bee Creek and Lakeway MUD No. 1. The area was presented as Area 24 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	312	325	343	420	550

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-3 be constructed by 1975. The cost of the proposed collection system, including a lift station and engineering and contingencies, is estimated to be $197,000. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975,

both having an initial design capacity of 0.055 mgd. The cost of the 0.055 mgd secondary treatment facility and filtration plant is estimated to be $97,680. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $126,500.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Bee Creek - East Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.055 mgd conventional secondary treatment facility at an approximate capital cost of $79,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $50,000.

Bee Creek - West Area.

This area is located along the south shore of Lake Travis and the western side of the mouth of Bee Creek. The area was presented as Area 25 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections through 1990, as given in the *Highland* Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	343	357	375	448	550

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-3 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $390,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.055 mgd. The cost of the 0.055 mgd secondary treatment facility and filtration plant is estimated to be $97,680. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $126,500.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Bee Creek - West Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.055 mgd conventional secondary treatment facility at an approximate capital cost of $79,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $50,000.

Therman Bend Area.

This area is located on the south side of Lake Travis in the Therman Bend of the Colorado River. This area was presented as Area 26 on Lake Travis under Plan A, Sub-Area 3 in the Phase II Highland Lakes Report. The population projections through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are shown below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	217	235	263	357	600

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-3 be constructed by 1975. The cost of the proposed collection system, including a lift station and engineering and contingencies, is estimated to be $229,900. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.03 mgd. The cost of the 0.03 mgd secondary treatment facility and filtration plant is estimated to be $72,300. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $104,400.

To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities, collection system expansions, and lift stations would be $88,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Therman Bend area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.03 mgd conventional secondary treatment facility at an approximate capital cost of $55,400.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $27,500.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Point Venture.

Point Venture is a new lakeside community located at Anderson Bend on Lake Travis. The community will ultimately have 1,200 residential dwellings. There will be 800 single-family houses and 400 townhouses. Presently there are about 100 townhouses and 15 single-family houses. It is proposed to build 15 to 20 houses per year to a total of 800 with the ultimate 400 townhouses constructed within three years.

Using this information and assuming 3.5 persons per dwelling, the following projected population table is derived:

Population Projections

Year	1970	1980	1990	2000	2010	2020
Projection	400	2,000	2,660	3,200	3,700	4,200

Plans for the collection system to serve future development are now under design by Bryant-Currington, Inc., Consulting Engineers of Austin and Associated Engineering Consultants, Inc., of Houston, and were not available at the time this report was prepared.

There are two existing secondary treatment package plants at Point Venture. The first plant is an extended aeration plant with a capacity of 0.036 mgd. The second plant is a similar type plant with a capacity of 0.05 mgd. The 0.036 mgd plant serves a club complex, and the 0.05 mgd plant treats sewage from the existing residential development which is served by a combination pressure sewer system and gravity sewer system as shown on Plate HL-3. The secondary effluent is used to irrigate golf courses; therefore, Point Venture has a no-discharge permit with the TWQB. Plans are to continue this method of effluent disposal. Excess sludge is removed by vacuum truck service. There are plans to construct a second 0.05 mgd plant adjacent to the first one within the next 18 months. It is recommended that the 0.036 mgd plant be abandoned upon completion of the second 0.05 mgd plant and that all sewage from the Point Venture development be treated at the site of the two 0.05 mgd plants. From the population projections above and assuming 100 gpcd as a design criteria for sewage treatment facilities, it is proposed that an additional 0.15 mgd plant be constructed by 1975. The estimated cost for this 0.15 mgd expansion of the secondary treatment facilities would be $157,560. This plant, plus the two 0.05 mgd plants, should be adequate until 1986. At this time a second 0.15 mgd plant is proposed giving a total capacity of 0.40 mgd which should be adequate until year 2020. The estimated cost for this second 0.15 mgd expansion of the secondary treatment facilities would be $157,560.

Since the secondary effluent is used to irrigate 34 acres of golf course at present and there are plans to construct another golf course of approximately the same size, no tertiary treatment facilities are proposed for Point Venture. This total area of golf course land would be adequate to receive the projected flow for year 2020 conditions assuming the overland runoff method of land disposal and application rate of approximately two inches per week.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should Point Venture wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $157,560, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $314,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $269,000, including engineering and contingencies.

Lakeway Area.

The Lakeway area is located along and contiguous to the southern shore of Lake Travis in Travis County as shown on Plates HL-3 and HL-3a. Lakeway consists of two separate but interrelated entities: the new Lakeway Municipal Utility District No. 1, and the older Lakeway area not within the Lakeway MUD No. 1.

The Lakeway MUD No. 1 contains approximately 3,343 acres consisting of three tracts of approximately 2,978 acres, 92 acres, and 273 acres. According to the Master Plan for Lakeway MUD NO. 1 prepared by Freese, Nichols, and Endress, Inc., Consulting Engineers, there will be about 3,967 single-family lots, 219 townhouses, 576 cluster homes, 362 villas, 3 schools, 5 churches, and other facilities which will comprise the community within the District. Using an average of 3.5 persons per dwelling unit, the ultimate resident population for the District would be 17,934. However, the engineers for the District, using population equivalents for other non-residential but sewage contributing areas within the District, have arrived at a total ultimate population equivalent of 21,890 persons for the purpose of designing water and sewage facilities.

Phased population projections for the Lakeway MUD No. 1 from the present through ultimate development are not available. The Lakeway Land Company owns the property within the District and sells lots and tracts to individual developers for constructing the proposed dwelling units. Therefore, population increase is dependent upon the sale of property and construction of dwelling units, which cannot be projected on any sound basis. For the purpose of this report, it was assumed that the District population projections would increase at the same rate as those for the older Lakeway area beginning about 1980. Construction is presently underway in the World of Tennis area and the area designated Villas as shown on Plate HL-3a.

It is estimated that by 1975, 106 lots in the World of Tennis area will be complete and 230 Villas in the extreme northern part of the area will be complete. Using 3.5 persons per dwelling a 1975 population projection of 1,175 is obtained. The remainder of the population projections for the District is given below. From the population projections, it appears the ultimate development will occur in year 2010.

Population Projections

Year	1970	1975	1980	1990	2000	2010	2020
Population		1,175	1,700	6,000	12,500	21,890	21,890

The older Lakeway area, consisting of approximately 1,267 lots, is also shown on Plate HL-3a. The area is not completely developed at this time, and it is estimated that there are about 410 houses existing. Using the population projections for this area given in the Highland Lakes Report by Freese, Nichols, and Endress, Inc., Consulting Engineers, and the ultimate number of lots available, the following population projections were derived.

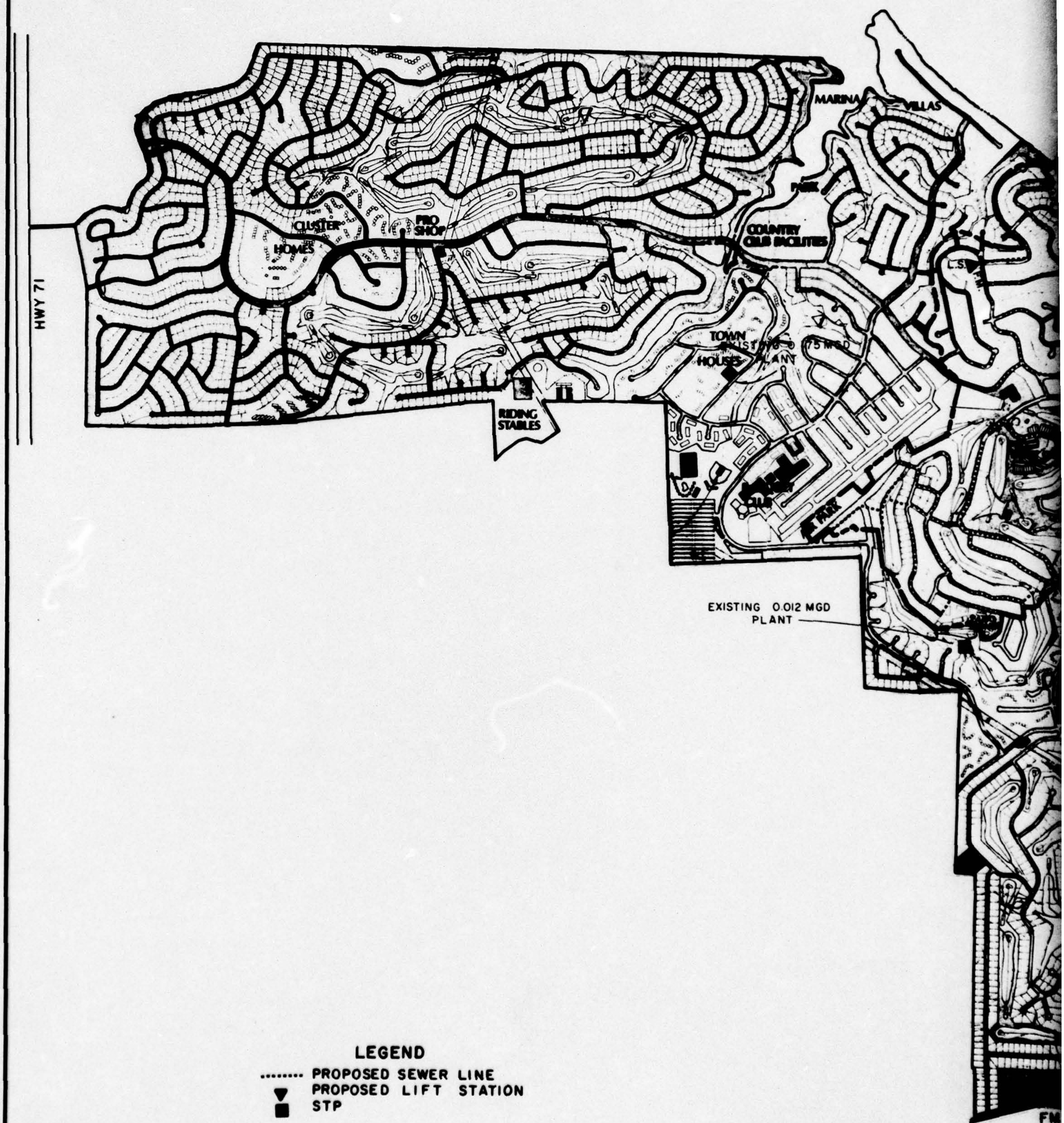
Population Projections

Year	1970	1980	1990	2000	2010	2020
Population	732	2,100	3,300	4,435	4,435	4,435

It seems that ultimate development is expected about the year 2000. This area is not within the Lakeway MUD No. 1, as mentioned above, and it is not likely that it will be in the future. For this reason, this area would probably have to form its own utility district for the purpose of constructing sewage collection systems. It is recommended that sewage from this area be treated either at an existing District sewage treatment plant or the subregional plant proposed to ultimately serve the entire District. Under this arrangement, the older Lakeway area by forming their own utility district would pay only for their own collection system and not have to share the cost of the entire District's utility improvements if it were annexed into the District. Sewage from this area could be treated at the District's plant if a contractual agreement between Lakeway MUD No. 1 and the older Lakeway area was created.

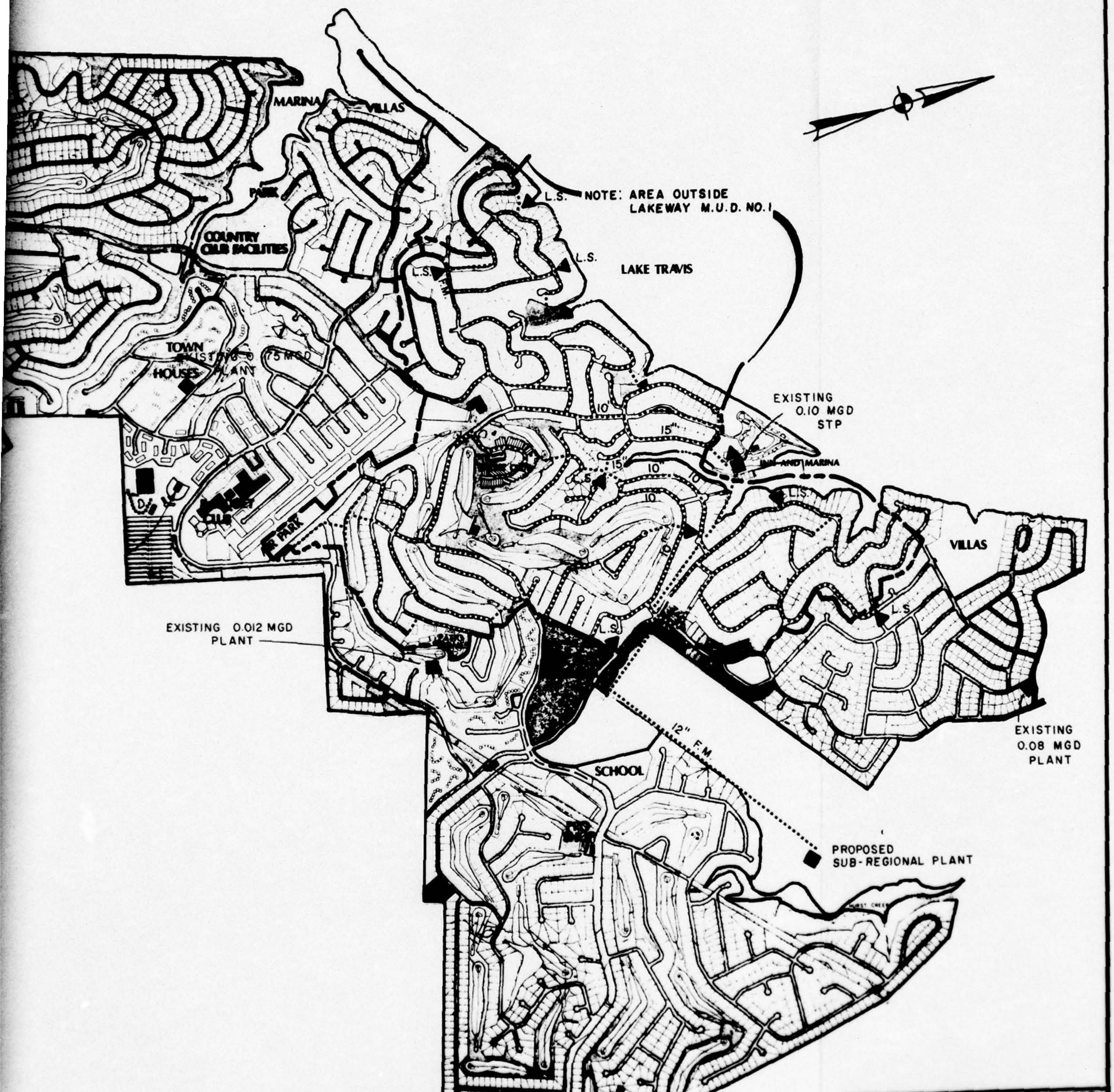
The cost for a collection system to tie into the subregional plant proposed to ultimately serve the entire District is estimated to be $1,826,800 by 1975 and $92,300 by 1990.

For the purpose of determining the capacity of sewage treatment facilities required, the two population projections from the older Lakeway area and Lakeway MUD No. 1 were added together with the resulting population projections for the entire Lakeway area:



LEGEND

PROPOSED SEWER LINE
PROPOSED LIFT STATION
STP



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKEWAY, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2000'
PLATE HL-3a

Population Projections

Year	1970	1975	1980	1990	2000	2010	2020
Population	732	2,575	3,300	9,300	16,935	26,325	26,325

There are four existing sewage treatment plants in the Lakeway area at the present time. All four are in operation or on standby. The first plant constructed was designed to serve the Lakeway Inn and Marina and has a design capacity of approximately 0.10 mgd. The second plant, which went into operation in March, 1973 serves the Lakeway World of Tennis, Sections 20 and 23. Its design capacity is reported to be 0.175 mgd. The third plant, (formerly owned by the Meta Corporation), now under construction, will serve the Rock Cove area, Casa Verde Condominium, Treetops, Sections 18 and 19. The design capacity of this plant will be 0.08 mgd. The fourth plant, now under construction, will serve approximately 35 units in the Greenway Cluster Homes area. The plant, which will have a design capacity of 0.012 mgd, is owned by Commercial Designs Incorporated, who purchased the plant site and tract of land for the Cluster Homes from the Lakeway Land Company. The plant, however, will be maintained and operated by the same personnel that operate and maintain the existing Lakeway plant.

Secondary sewage effluent from the existing Inn and Marina sewage treatment plant is presently pumped to a holding pond having a capacity of approximately 7.0 mg from which water is pumped to irrigate 105 acres of existing golf course. This method of effluent disposal is also proposed to continue throughout the study period for all plants. The ultimate area of golf courses proposed for the Lakeway MUD NO. 1 is 270.8 acres, as given in the Master Plan report prepared for the District. For the ultimate population of 26,325, the land area required for the overland runoff application method is 365 acres (according to Table 11-6 in the "Assessment of the Effectiveness and Effects of Land Disposal Methodologies of Wastewater Management," Department of the Army Corps of Engineers, Wastewater Management Report 72-I). Therefore, an additional 95 acres of spray field will be required by year 2010. The existing 105 acres of golf course is capable of renovating secondary effluent from a population of 7,565, which will occur sometime after 1990 according to the population projections.

Cost estimates presented in this discussion do not include the spray irrigation system or its operation and maintenance since it is a necessary part of maintaining the golf course and was not constructed solely for the disposal of sewage effluent.

For the purpose of presenting a phased cost estimate breakdown for the Lakeway MUD No. 1, it will be assumed that the proposed collection system for the District will be constructed in two stages. The first stage will be assumed to consist of 25 percent of the collection lines proposed for Tract 1 and be constructed by 1975. The remaining collection system will be assumed to be constructed in 1990, and consist of the remaining

lines proposed for Tract 1 and the systems proposed for Tracts 2 and 3. The cost for the proposed 1975 collection system improvements is estimated to be $1,435,800. The cost for the 1990 proposed collection system improvements is estimated to be $5,053,200.

An expansion of 0.225 mgd capacity is proposed for the World of Tennis treatment plant to serve future development in this area. The total design capacity of 0.40 mgd would serve the tennis complex and approximately 500 dwellings until a proposed subregional plant is constructed to serve the entire Lakeway area.

The site of the proposed subregional plant is shown on Plate HL-3a. It is planned to construct the first increment of this plant by December, 1974. The primary purpose of this initial increment will be to serve planned development southeast of the plant site which is starting at the present time. The second purpose of the initial increment of the plant will be to allow abandonment of the 0.08 mgd plant (Rock Cove) sometime before 1980.

It is recommended that the first increment of the subregional plant (to be constructed by December, 1974) be sized to serve the older Lakeway area, the Villas in the Rock Cove area, and remaining areas not now developed. It is also proposed that the sewage from the World of Tennis area be treated at the proposed subregional plant when the capacity of the 0.175 mgd plant is reached. This would delete the need for the proposed 0.225 mgd expansion to the World of Tennis plant and further the trend toward regionalization of the Lakeway area.

The initial phase of the proposed subregional treatment plant would require a design capacity of 1.10 mgd to be adequate until 1990. The cost for this treatment plant is estimated to be $639,900.

By 1990 it is proposed that the plant become subregional to serve the entire Lakeway development with abandonment of all other existing plants in the Lakeway MUD area. An expansion of 1.5 mgd capacity in 1990 would be required to be adequate through year 2020, giving a total capacity of 2.6 mgd. The cost for this 1.5 mgd expansion is estimated to be $779,500.

It must be emphasized that the recommended phasing proposed above is based on the population projections derived for the entire Lakeway area. If the population increases at a rate different from the projections, the required sizes and phasing of the subregional plant will change as well as recommended abandonment plans.

There is also the possibility of other areas and developments in the Lakeway vicinity contracting with the MUD for sewage treatment services as is proposed for the older Lakeway area. In this event, the proposed sizes and phasing of the increments of the subregional plant would change. An example would be areas expected to develop on the east side of S.H. 620 and west of Lake Austin.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the Lakeway area wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $639,900, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $170,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $144,000, including engineering and contingencies.

Cox Hollow Area.

The Cox Hollow area is located on the north side of Lake Travis and southeast of Lago Vista (Travis County MUD No. 1). The area was presented as Area 6 under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	154	182	287	462	600

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-4 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $152,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.04 mgd. The cost of the 0.04 mgd secondary treatment facility and filtration plant is estimated to be $83,200. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $115,300.

To meet the wastewater treatment requirements for an increasing population, a 0.02 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.02 mgd expansion of only the secondary treatment and filtration facilities and a lift station would be $66,600.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Cox Hollow area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.04 mgd conventional secondary treatment facility at an approximate capital cost of $67,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $36,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Lago Vista (Travis County MUD No. 1).

The Travis County MUD No. 1 consists of about 5,300 acres located in Travis County in the Baldwin Bend area of Lake Travis as shown on Plate HL-4. Most of the street pattern shown on Plate HL-4 is still in the proposed stage and not constructed at present.

A general plan of development has been prepared by National Resort Communities, Inc., for the area within the proposed district. The program is a long term one to produce a well balanced complex of residential, commercial, and recreational areas complimented with neighborhood parks, community centers, and schools.

A preliminary engineering report was prepared for the District in 1972, by Trico International, Inc., Civil Engineering, Tempe, Arizona. Population projections presented in the report for the District are presented below.

Population Projections

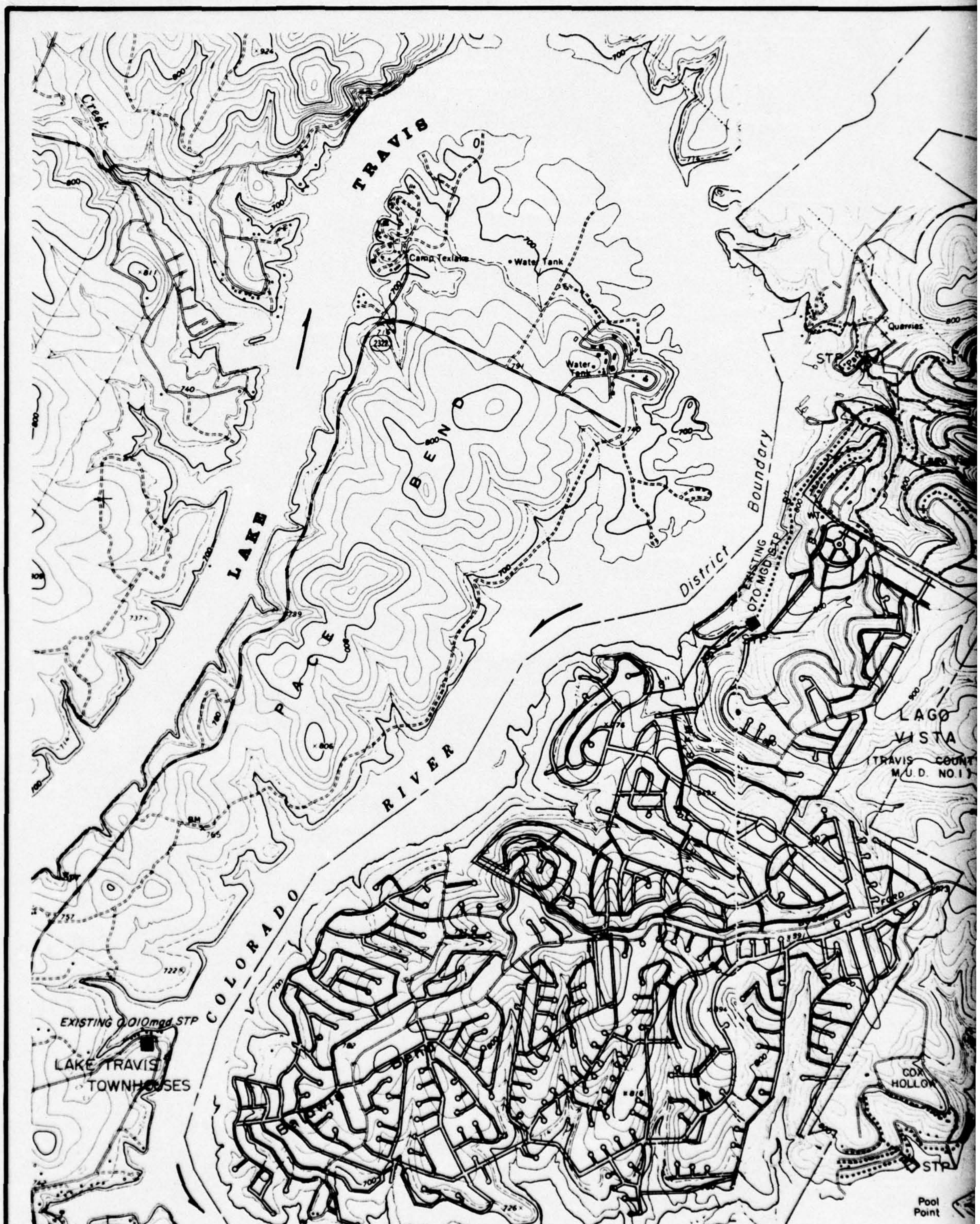
Year	1970	1980	1990	2000	2010	2020
Population		4,490	11,230	16,370	21,510	33,000

Population projections for the existing older development, part of which is not within the district, are shown below. The 1970 through 1990 projections were obtained from the Highland Lakes Report, and the 2010 and 2020 projections were obtained by extending the 1970-1990 projections.

Population Projections

Year	1970	1980	1990	2000	2010	2020
Population	176	526	876	1,060	1,200	1,400

There are approximately 3.5 miles of 4, 6, and 8-inch diameter gravity and pressure sewage collection lines existing within the District as shown


Creek
LAKE
TRAVIS
Camp Texlake
Water Tank
Water Tank
2322
PACE
BEND
COLORADO
RIVER
District Boundary
EXISTING 0.70 MGD STP
Quarries
STP
LAGO
VISTA
(TRAVIS COUNTY M.U.D. NO.1)
EXISTING 0.010mgd STP
LAKE TRAVIS TOWNHOUSES
COX HOLLOW
STP
Pool Point

LEGEND
PROPOSED SEWER LINE
EXISTING SEWER LINE
PROPOSED SEWAGE TREATMENT PLANT
EXISTING SEWAGE TREATMENT PLANT
PROPOSED LIFT STATION
EXISTING LIFT STATION
District Boundary
EXISTING 0.70 MGD STP
LAGO VISTA
(TRAVIS COUNTY M.U.D. NO 1)
Lago Vista
Bald Mountain
Quarries
STP
Water Tank
Little Cottonwood Hollow
Davis Hollow
Lakeshore Ranch Landing Strip
Lakeshore Ranch
COX HOLLOW
Pool Point
LOHMANN FORD ROAD
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAKE TRAVIS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE 1" = 3000'
PLATE HL-4

on Plate HL-4. The proposed sewer lines shown on Plate HL-4 would serve the existing older development. The proposed sewage system to serve the remaining proposed development within the district is not shown as plans were not available at the time this report was prepared. However, the preliminary engineering report prepared for the District estimated that about 116 miles of collection lines along with 39 miles of service laterals would be constructed by the District between 1975 and 1985. For this report it was assumed that the proposed collection systems to serve both the District and the older area would be constructed by 1975 at an estimated cost of $12,256,600.

There is also a new 0.07 mgd activated sludge sewage treatment plant in existence which serves the country club and which will serve the first phase of development. It is recommended that sewage from the existing Lago Vista developed area be treated at the site of the existing District treatment plant, the total sewage treatment capacity being determined from the sum of the two population projections.

Population Projections

Year	1970	1980	1990	2000	2010	2020
Population	175	5,016	12,106	17,430	22,810	34,400

It is proposed that effluent from the secondary sewage treatment facilities be used to irrigate approximately 170 acres of golf course.

Based on the total area population projections and a design criteria of 100 gpcd for sewage treatment facilities, a secondary treatment plant with an initial capacity of 1.0 mgd should be constructed by 1975, which would be adequate until about 1987. The cost of this proposed system, including the irrigation system, is estimated to be $846,000. By 1987, a second 1.0 mgd expansion of both the secondary treatment and irrigation facilities would be required and would be adequate until 2005. The estimated cost of these 1987 improvements is $845,900. A 1.5 mgd expansion of the secondary treatment facilities would be required by 2005 and would be adequate throughout the study period. The estimated cost of the year 2005 improvements is $826,000.

Although the existing 170 acres of golf course would not be adequate to receive the average flow of 3,500,000 gallons per day projected for year 2020, there is a total of 382 acres of golf course and 413 acres of parks proposed for ultimate development which would be more than adequate assuming a 2-inch per week application rate and the overland runoff method of land disposal.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should Lago Vista wish to implement a discharge plan, the following items would be required:

1. By 1977, construct conventional secondary treatment facility at an approximate capital cost of $616,200, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $343,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $244,000, including engineering and contingencies.

This discharge plan would require phased capacity expansions as presented in the no-discharge plan.

Whitecliff Corporation (Lake Travis Townhouses).

The Lake Travis Townhouses are located on the south side of Lake Travis approximately 0.8 mile north of the Pedernales Country Club and east of F.M. 2322 as shown on Plate HL-4. At present there are two existing townhouses with plans to construct up to 60 townhouses at this site. However, *no construction is in progress* at present and it is unknown when or if the remaining proposed townhouses will be constructed.

There is an existing 10,000 gallon per day extended aeration type package activated sludge plant serving the two townhouses. Assuming 2.5 people per townhouse, the plant would serve approximately 40 townhouses before requiring an expansion. Since further construction is uncertain at this time, no proposed improvements are recommended for the plant. If, however, construction continues, partial tertiary treatment facilities will be required to meet the effluent standards set forth in this report.

Old Ferry Road Area.

This area is located on the west side of the Pedernales River approximately 18,000 feet upstream from its confluence with Lake Travis. The area was presented as Area 28 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections for the area through 1990 as given in the Highland Lakes Report, along with a projection for year 2020, are as follows:

Population Projections

Year	1970	1975	1980	1990	2020
Population	312	319	326	354	500

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system

improvements shown on Plate HL-5 be constructed by 1975. The cost of the proposed collection system, including a lift station and engineering and contingencies, is estimated to be $163,100. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.05 mgd. The cost of the 0.05 mgd secondary treatment facility and filtration plant is estimated to be $90,500. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $121,000.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Old Ferry Road area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.05 mgd conventional secondary treatment facility at an approximate capital cost of $73,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $44,000.

Gloster Bend Area

This area is located on the north side of Lake Travis in the Gloster Bend of the Colorado River. The area was presented as Areas 2 and 3 on Lake Travis under Plan A, Sub-Area 3 of the Phase III Highland Lakes Report. The population projections for the area through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are presented below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	284	395	508	886	1,400

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-5 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $383,000. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.07 mgd. The cost of the 0.07 mgd secondary treatment facility and filtration plant is estimated to be $112,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $137,800.

To meet the wastewater treatment requirements for an increasing population, a 0.07 mgd expansion of the facilities would be required by 1985,

and would be adequate until the year 2020. The estimated cost for this 0.07 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $138,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Gloster Bend area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.07 mgd conventional secondary treatment facility at an approximate capital cost of $91,700.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $63,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Pedernales Country Club.

The Pedernales Country Club is located near the south shore of Lake Travis approximately four miles northeast of the intersection of S.H. 71 and F.M. 2322 and 1/2 mile east of F.M. 2322. The existing sewage treatment facility was constructed in 1968 and is an activated sludge plant with a design capacity of 15,000 gallons per day. The plant presently serves the country club, which has dining facilities. There are plans to construct within the year 15 condominium houses adjacent to the club house which would also be served by the sewage treatment facilities. Assuming 3.5 people per dwelling and a design criteria of 100 gallons per person per day, the average sewage flow from these units would be 5,250 gallons per day.

There are no flow records available, but assuming five gallons per meal served in the dining area and 9,750 gallons per day available capacity when the condominiums are constructed, this would allow 1,950 meals per day to be served. Based on these assumptions, it appears that the existing secondary treatment plant is of adequate capacity for the future. The secondary effluent from the treatment plant is used to irrigate park land adjacent to the plant site. There is also a nine-hole golf course available for irrigation with the effluent by means of pop-up type sprinkler system. Therefore, the method of effluent disposal is adequate for the present and future based on the above-mentioned facilities and conditions.

Spicewood Beach Area.

The Spicewood Beach area is located on the south shore of Lake Travis - across from the Turkey Bend of the Colorado River and north of the confluence of Alligator Creek with Lake Travis. This area was presented as Area 29 on Lake Travis under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections for the area through 1990, as

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LEGEND

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▼ PROPOSED LIFT STATION
■ PROPOSED STP

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

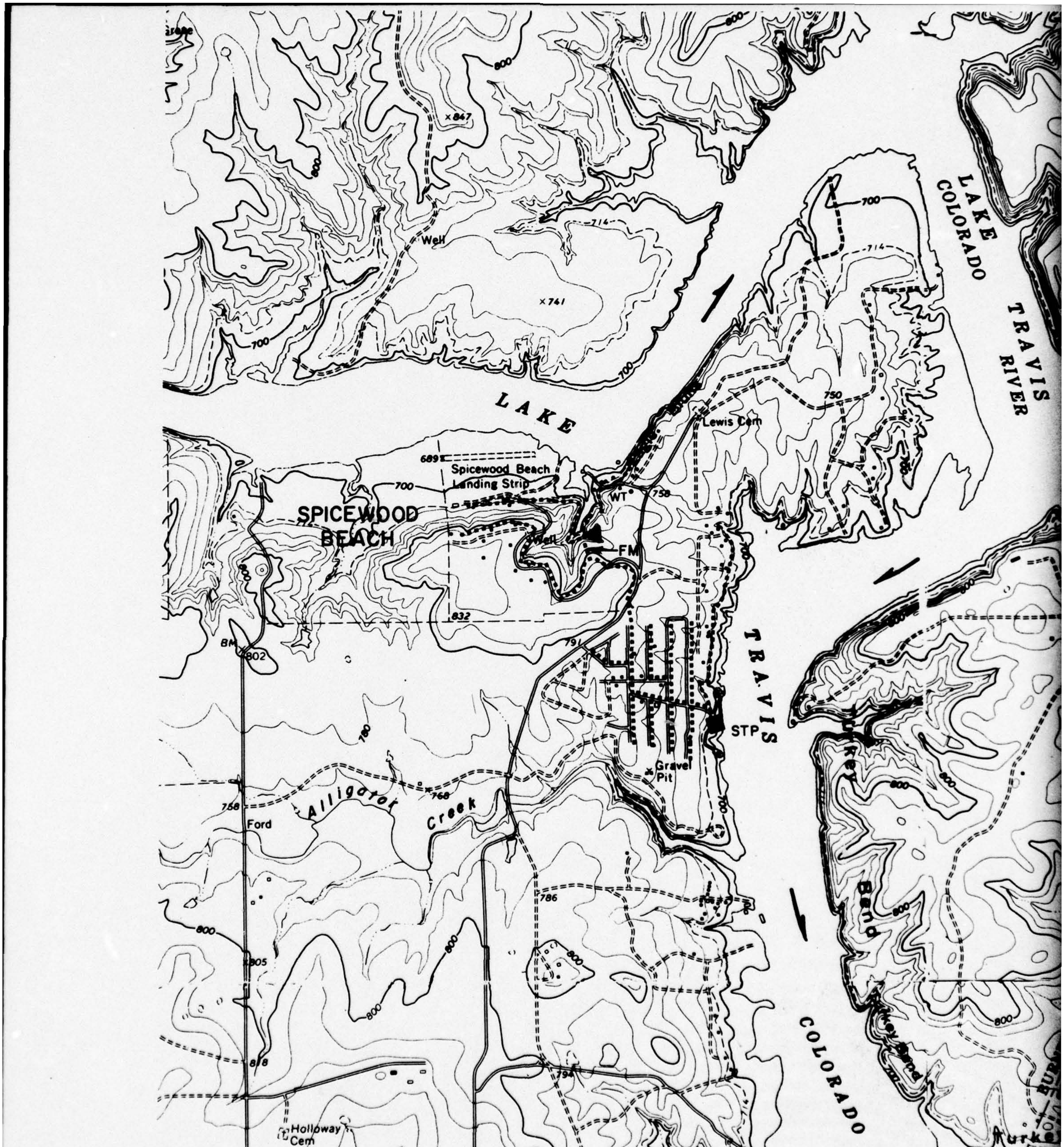
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE TRAVIS

TURNER, COLLIE & BRADEN, INC. - HOUSTON / PORT ARTHUR

SCALE: 1" = 3000' PLATE HL-5

2



LAKE
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Spicewood Beach
Landing Strip
SPICEWOOD
BEACH
WT
758
Well
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832
791
BM
802
780
STP
Gravel
Pit
768
758
Alligator
Creek
Ford
786
805
818
794
Holloway
Cem
842
848
Bend
740

LEGEND

- PROPOSED SEWER LINE
- ▼ PROPOSED LIFT STATION
- ■ PROPOSED STP

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE TRAVIS 2

given in the Highland Lakes Report, along with a projection for year 2020 are presented below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	235	266	308	410	600

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-6 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $311,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.06 mgd. The cost of the 0.06 mgd secondary treatment facility and filtration plant is estimated to be $104,920. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $131,800.

It is therefore recommended that all steps necessary to implement the *aforementioned discharge* plan be undertaken. However, should the Spicewood Beach area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.06 mgd conventional secondary treatment facility at an approximate capital cost of $85,700.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $54,000.

Lake Marble Falls Area
(Plate HL-7)

Introduction.

The number of houses, categorized by permanent and temporary and adjacent to Lake Marble Falls (excluding the City of Marble Falls) as presented in the Highland Lakes Report, is shown below.

Estimated Number of Houses

Lake Marble Falls (both sides)	1970	1975	1980	1985	1990
Permanent Houses	129	320	443	580	733
Temporary Houses	488	459	693	802	895

The table indicates that the number of permanent houses compared to the number of temporary houses should remain about constant, with slightly more houses being in the temporary category.

The soils surrounding Lake Marble Falls are of two general types. Most of the soils on the north side of the lake are of the Tishomingo Gravelly Soils - Rough Rocky Land series. The Tishomingo soils are characterized by reddish brown to brown, very friable, slightly acid, sandy loam, 5 to 12 inches thick, over yellowish-red, friable to firm, sandy clay underlain by partly weathered granite or gneiss at depths of 10 to 30 inches beneath the surface. All layers contain a large percentage of rounded quartz crystals. The soils are gently sloping, ranging from 1 to 5 percent. The Rough Rocky Land association is a rolling to steep area of granite and gneiss stones and bedrock outcrops with little or no soil covering.

The soils on the south side of the lake and the north side of the lake in the vicinity of Max Starcke Dam are of the Tarrant-Crawford series. The Tarrant soils are characterized by dark brown to dark grayish-brown, friable, highly calcareous clay, 4 to 8 inches thick, over broken or partly weathered limestone or limestone bedrock at depths less than 12 inches beneath the surface. They are gently sloping to hilly (2 to 20 percent slopes). Crawford soils are dark reddish-brown, firm, slightly acid 8-12 inches thick, grading into a reddish brown, stiff, blocky, slight acid clay over limestone bedrock. Slopes are nearly level to gently sloping (1/2 to 3 percent slopes).

The permeability of the soils is moderately low, in the 0.2 to 0.63 inches per hour range. They are reported to be severely limiting with respect to most engineering properties including pond reservoir areas, pond embankments, excavated ponds, septic tank drain fields, and local roads and streets.

The Tarrant-Crawford soils are the only association in the area that could have a potential for land disposal. In this report, however, due to the slope requirements of this method of land disposal, the method of tertiary treatment proposed for the Lake Marble Falls area is filtration. As was mentioned in the discussion of Lake Travis, if suitable land sites become available upon construction of secondary treatment facilities, land disposal may be substituted for filtration.

Water is supplied for individual homes along Lake Marble Falls by private wells and for the City of Marble Falls by a water treatment plant owned by the Marble Falls WCID No. 1. The plant, which pumps raw water from the lake, has a capacity to treat approximately one million gallons per day, although the present demand is about 500,000 gallons per day. Both the filter backwash water and lime treatment sludge are discharged into Lake Marble Falls.

<u>City of Marble Falls</u>.

The City of Marble Falls is an incorporated city located on Lake Marble Falls, approximately one mile upstream from Max Starcke Dam. Most of the City lies along the north shore of the lake, but a small area is included on the south shore.

A large portion of the City is drained by Whitman Branch, which flows through the central part of the incorporated area in a north-south direction. Drainage is provided by roadside ditches and overland flow, as there are no stormwater collection systems existing.

The City is underlain by soils of the Tishomingo and Rough Rocky associations described at the beginning of the Lake Marble Falls area discussion. Although most of the City is served by the sewage collection system shown on Plate HL-7, there are two areas served by septic tanks. One area is within the city limits on the north side adjacent to U.S. 281. The other area is located south of the city limits adjacent to Lake Marble Falls. Although no problems have been noticed with the septic tanks as of yet, this is due to the fact that the houses are scattered and the distances between them are relatively large. As development in these areas becomes more concentrated, problems are imminent due to the poor properties of the soil with respect to septic tank drain fields.

Population data developed by the TWDB for use in this study are presented below for Marble Falls.

<u>Population Projections</u>

Year	1970	1980	1990	2020
Population	2,209	2,260	2,300	2,240

From the population projections, it appears that little development and growth is expected for the City over the study period. This projection is

validated by the fact that people moving into the area are attracted by new lakeside communities rather than older established cities. At present there are an estimated 875 water connections and 600 sewer connections within the City.

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central area of the City. The City is accessible by U.S. 281 and F.M. 1431 and is served by a spur line of the Southern Pacific Railroad.

The projected water uses for the City, a reflection of the population trend, were calculated based on projected data supplied by the TWDB and are as follows:

Population Projections

	Year			
	1970	1980	1990	2020
Municipal Use (mgd)	0.205	0.248	0.265	0.305
Industrial Use (mgd)	0.215	0.251	0.289	0.444

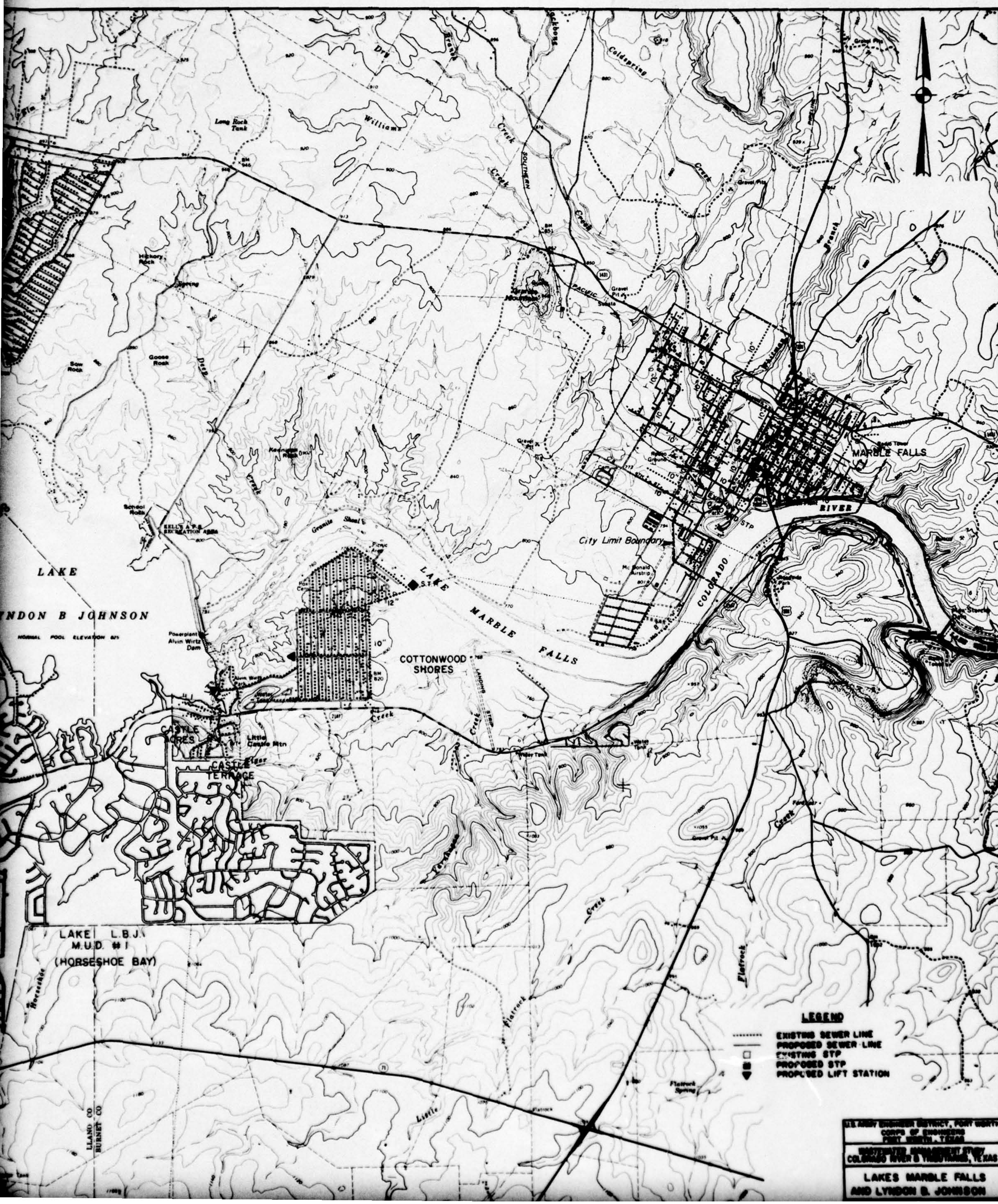
Municipal wastewater return flows projected for the City by the TWQB are as follows:

Wastewater Return Flows

	Year			
	1970	1980	1990	2020
Flows in mgd	0.220	0.230	0.230	0.220
BOD in lb/day	376	407	414	426
TSS in lb/day	442	475	506	515

The City's existing sewage collection system, as shown on Plate HL-7, consists of 6- and 8-inch laterals and 10- and 15-inch mains. As mentioned before, most of the City and District are served by the collection system, the major exceptions being the two septic tank areas. The proposed sewage collection lines, show on Plate HL-7, were presented in the Highland Lakes Report and will provide sewer service to the septic tank areas in addition to relieving the system in the northeast area of the City, which is reported to be inadequate to handle wet weather flows. It is recommended that these proposed collection system improvements be constructed by 1975. The cost for these proposed collection system improvements, including 15,400 feet of 8-inch line, 11,200 feet of 10-inch line and engineering and contingencies, is estimated to be $508,500.


DRY CREEK
SHERWOOD SHORES
COLORADO RIVER
NORMAL POOL ELEVATION 825
LAKE LYNDON B JOHNSON
SUNRISE BEACH M.U.D. #1
District Boundary
City Limit Boundary
CITY OF GRANITE SHOALS
S.T.P.
STP
INDEFINITE BOUNDARY
BURNET CO
LLANO CO
WALNUT CREEK
SANDY CREEK
Golf Course
Water Tanks
Picnic Area
LAKE
LYNDON B JOHNSON
NORMAL POOL ELEVATION 825
Gravel Pit
Water Tank
District Boundary
EXISTING 0.240 MGD STP
Blue Lake Landing Strip
Hardin Hill
Mosquito Hill
LAKE L.B.J. M.U.D. #1
(HORSESHOE BAY)
Sow Rock
Goose Rock
Hickory Rock
Powerplant Alvin Wirtz Dam
Walnut Creek
Sandy Branch
Spring Branch
Pecan
Branch
Slickrock
Horseshoe
Cedar
Cem
Quarry


LAKE
LYNDON B JOHNSON
NORMAL POOL ELEVATION 825
LAKE MARBLE FALLS
COLORADO
RIVER
MARBLE FALLS
City Limit Boundary
STP
COTTONWOOD SHORES
CASTLE TERRACE
Little Castle Mtn
Powerplant Alvin Wirtz Dam
LAKE L.B.J. M.U.D. #1 (HORSESHOE BAY)
LLANO CO
BURNET CO
Hickory Rock
Goose Rock
Long Rock Tank
Williams
Coldspring
Creek
SOUTHERN PACIFIC
Flatrock
Flatrock Spring
Horseshoe
Mc Donald Airstrip
10"
12"
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
EXISTING STP
PROPOSED STP
PROPOSED LIFT STATION
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAKES MARBLE FALLS
AND LYNDON B. JOHNSON

The existing wastewater treatment plant is located in the southern part of the City and was constructed about 1961. It consists of a clarigester, trickling filter, final clarifier, sludge drying beds, chlorination facilities, and a holding pond having a capacity of approximately one million gallons to receive any bypassed sewage due to lift station failure. The design capacity of the plant is approximately 0.24 mgd, which should be adequate throughout the study period. By 1975, the construction of a filtration plant having a design capacity of 0.23 mgd is recommended. The estimated cost of this filtration plant is $44,500. By 1983 nitrification, denitrification and phosphorus reduction facilities should be constructed at an approximate capital cost of $223,500.

The effluent from the plant is discharged into an outfall line which carries the flow downstream to a point within the lake, approximately 200 feet above the Max Starcke Dam. Sludge from the drying beds is hauled off by individuals and spread on pasture land.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the City of Marble Falls wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.24 mgd conventional secondary treatment facility at an approximate capital cost of $207,900, including engineering and contingencies.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $195,000.

Cottonwood Shores Area.

The Cottonwood Shores Area, as shown on Plate HL-7, is located in the vicinity of the Alvin Wirtz Dam and includes developed area along the south shore of Lakes Marble Falls and Lyndon B. Johnson. The Cottonwood Shores subdivision is located below Alvin Wirtz Dam between F.M. 2147 and the Granite Shoal of the Colorado River. The small Castle Acres subdivision is located just behind Alvin Wirtz Dam adjacent to F.M. 2147, and the Castle Terrace subdivision is just south of Castle Acres and includes part of Little Castle Mountain. Most of the area is served by a private water system owned by D. R. Belknap with approximately 175 water connections presently being served by the system. Water is supplied by a water treatment plant which obtains raw water from Lake LBJ. The capacity of the water treatment plant is reported to be 200 gallons per minute.

Population projections for the area from 1970 to 1990 were derived from the Highland Lakes Report, and a projection of this data was used in obtaining a figure for year 2020 as shown below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	876	900	1,100	1,600	3,000

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-7 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $589,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.15 mgd. The cost of the 0.15 mgd secondary treatment facility and filtration plant is estimated to be $178,600. This initial design capacity would be adequate until about 1988. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $180,000.

To meet the wastewater treatment requirements for an increasing population, a 0.15 mgd expansion of the facilities would be required by 1988, and would be adequate until the year 2020. The estimated cost for this 0.15 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $213,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Cottonwood Shores Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.15 mgd conventional secondary treatment facility at an approximate capital cost of $157,500.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $130,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Lake Lyndon B. Johnson Area
(Plates HL-7 through HL-9)

Lake Lyndon B. Johnson, originally called Lake Granite Shoals, is located along the boundary between Burnet County on the north and east and Llano County on the south and west. This is one of the most popular of the Highland Lakes for developers and retired people.

The number of houses by permanent and temporary categories adjacent to the lake, projected from 1970 to 1990 as given in the Highland Lakes Report, is shown below to indicate the trend of development expected for Lake LBJ.

	Number of Houses				
Lake LBJ	1970	1975	1980	1985	1990
East Side (Burnet County)					
Permanent	814	1,357	1,715	2,149	2,586
Temporary	704	610	701	716	729
West Side (Llano County)					
Permanent	487	680	1,286	2,091	2,663
Temporary	1,140	1,428	1,303	979	488

The table shows that at present a larger percentage of the homes on the east side of the lake are permanent, while those on the west side consist mostly of temporary dwellings. From the above projections, the lake is expected to develop rather uniformly on both sides, with the permanent to temporary ratio being larger on the west side. This projection would seem valid due to the newly-created Sunrise Beach MUD No. 1 and the Lake LBJ MUD No. 1 (Horseshoe Bay) developements, which are proposed to be separate communities consisting mostly of permanent homes.

The largest development on the east side of the lake at present is the Sherwood Shores area, which includes the incorporated City of Granite Shoals and accounts for approximately 60 percent of the homes (both permanent and temporary) on this side of the lake.

The soils along the entire east side of the lake (in Burnet County) are of the Tishomingo Gravelly Soils - Rough Rocky Land association as described for Lake Marble Falls. The soils on the west side of the lake are of three general types. A small area just above Alvin Wirtz Dam consists of Tarrant-Crawford clays. From F.M. 1431 to the confluence of Spring Branch with Lake LBJ, soils generally consist of the Tishomingo-Katemcy association. The remainder of the lake from this point north is underlain by soils of the Tishomingo-Pontotoc association. The Katemcy and Pontotoc soils are described briefly below.

Katemcy Soils - These soils are characterized by dark grayish brown to dark brown, friable, slightly acid, sandy loam to clay loam surface, 8 to 12 inches thick, over reddish brown to dark reddish brown, firm, blocky, slightly acid, sandy clay. They are nearly level with slopes ranging from 0 to 1-1/2 percent. The permeability of the surface layer (0 to 9 inches) ranges from 0.63 to 2.0 inches per hour; however, from 9 to 35 inches, permeability is very low, ranging from 0.06 to 0.20 inches per hour.

Pontotoc Soils - These soils are characterized by dark reddish brown to reddish brown, friable, slightly acid, sandy loam surface, 10 to 15 inches thick over reddish brown to yellowish brown, friable, granular, slightly acid, sandy, clay loam over sandstone or partly weathered sandstone at 30 to 45 inches. They are nearly level to gently sloping with 1 to 4 percent slopes. Permeability is reported to be moderate, probably in the 0.63 to 2.0 inches per hour range. Only a small portion of the Tishomingo-Pontotoc series is reported to consist of the Pontotoc type (15 percent county-wide).

Due to the wide range of variations in the soil types and their characteristics with respect to their potential for land disposal, tertiary treatment by means of filtration will be proposed for Lake LBJ in this report. One example in support of this decision is the Sunrise Beach MUD No. 1. This area contains soils of the Tishomingo, Katemcy, and Pontotoc associations. From the general characteristics, it would appear that the Katemcy soils may have a potential for the overland runoff method of land disposal (although slopes are below the minimum two percent used as a standard in this report), and the Pontotoc soils appear to have a good potential for the spray irrigation method. However, in the preliminary engineering report prepared for the District, it was reported that no land areas within the District were suitable for land disposal of the effluent. Water is supplied to residences and other establishments along the lake by private companies, MUD water systems, and individual wells. Most of the larger water systems use raw lake water as their source and operate water treatment plants to soften, clarify and disinfect the water before distribution to their customers.

Lake LBJ MUD No. 1 (Horseshoe Bay).

The Lake Lyndon B. Johnson MUD No. 1 is a new District located along the south shore of Lake LBJ just above Alvin Wirtz Dam as shown on Plate HL-7. Development within the Horseshoe Bay area will include single-family houses, duplexes, townhouses, condominiums, apartments, mobil home lots, and commercial areas. There are only about 30 houses in existence at this time. Population projections for the area are not now available, as this is dependent upon construction and sale of dwellings. The engineers for the District, Coulson and Associates Engineers, Inc., Houston, Texas, supplied ultimate population estimates for the area along with the layout of the existing sewage collection system for Phase I as shown on Plate HL-7.

The estimated population data for the Horseshoe Bay area as supplied by the engineers for the District follows:

Land Use	Number of Lots	Population Estimate
A. Phase I		
Single-Family	2,399	8,397
Duplexes	177	1,062
Townhouses	212	466
Condominiums	69	607
Apartments	87	3,253
Airport Commerical	10	50
Commerical Center	105	525
Service Stations	6	21
Total Phase I		14,381
B. Phase IIA and IIB		
Single-Family	867	3,035
Mobile Homes	902	1,985
Townhouses	6	14
Total Phase IIA and IIB		5,034
Total Poulation Phase I, IIA, & IIB		19,415

In order to arrive at incremental population projections throughout the study period, it was assumed that the Horsehoe Bay area would develop at the same rate as the Lakeway MUD No. 1, which has similar characteristics. The resulting population projections for the Horseshoe Bay area are presented below. Ultimate population is projected to occur about year 2010.

Population Projections

Year	1970	1980	1990	2010	2020
Population		1,650	5,825	19,415	19,415

There is an existing sewage treatment plant serving initial development in the Horseshoe Bay area. It is a contact-stabilization form of activated sludge treatment plant and was constructed in 1972. The design capacity is reported to be 0.10 mgd. Effluent from the plant flows into a five-acre holding pond from which water is pumped to irrigate 160 acres of golf course.

A new plant is now under construction which will have a design capacity of 0.50 mgd. A tertiary sewage treatment plant is also being constructed in addition to the secondary facilities which will include lime clarification (Neptune Microfloc). Effluent from the secondary and tertiary treatment facilities will be stored in the five-acre holding pond and will also be used to irrigate the golf course area.

Based on the population projections presented above, the total capacity of the treatment facilities (0.60 mgd) would be adequate until about 1991. At that time, it is recommended that an expansion to the facilities be constructed having a design capacity of 1.30 mgd, which would be adequate through year 2020. This expansion is assumed to be for both the secondary and tertiary treatment facilities. The estimated cost for this proposed expansion is $953,300. It is also recommended that irrigation of the golf course be continued with the tertiary treatment plant effluent since lake water from Lake LBJ is presently used for this purpose in combination with existing secondary effluent.

The layouts of the proposed collection systems which will serve Phases IIA and IIB are presently under design and were not available at the time this report was prepared. Therefore, cost estimates presented for Horseshoe Bay do not include collection system costs.

It is therefore recommended that the aforementioned no-discharge plan be continued. However, should Horseshoe Bay wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $220,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $181,000, including engineering and contingencies.

<u>Sandy Creek Area.</u>

The Sandy Creek area is located on the south shore of Lake LBJ, adjacent to and along the east bank of Sandy Creek at its confluence with Lake LBJ. This area includes the Blue Lake Estates and Deer Haven subdivisions. The area was presented as Areas 17 and 20 under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections for the area from 1970 to 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

<u>Population Projections</u>

Year	1970	1975	1980	1990	2020
Population	599	763	804	1,173	1,450

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-7 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $409,500. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.10 mgd. The cost of the 0.10 mgd secondary treatment facility and filtration plant is estimated to be $147,000. This initial design capacity would be adequate until about 1989. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $158,800.

To meet the wastewater treatment requirements for an increasing population, a 0.045 mgd expansion of the facilities would be required by 1989, and would be adequate until the year 2020. The estimated cost for this 0.045 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $124,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Sandy Creek area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.10 mgd conventional secondary treatment facility at an approximate capital cost of $121,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $88,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Walnut Creek Area.

The Walnut Creek area is located at the confluence of Walnut Creek with Sandy Creek along the south bank of Sandy Creek. The area was presented as Area 19 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. the projected population for the area from 1970 through 1990, as given in the Highland Lakes Report, is given below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	224	273	333	438	600

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-7 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies.

is estimated to be $254,800. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.06 mgd. The cost of the 0.06 mgd secondary treatment facility and filtration plant is estimated to be $104,920. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $131,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Walnut Creek area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.06 mgd conventional secondary treatment facility at an approximate capital cost of $85,700.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $55,000.

Sunrise Beach (Sunrise Beach MUD No. 1)

Sunrise Beach is located on the west side of and along the shores of Lake Lyndon B. Johnson in Llano County, Texas as shown on Plate HL-7. The Sunrise Beach and Granite Shoals Lake Estates subdivisions, which comprise the area within the Sunrise Beach MUD No. 1, are partially developed residential communities with some commercial but no industrial activity. The area is presently served entirely by septic tanks, but treated water is available from the Sandy Mountain Development Company, a privately-owned water utility.

At present there are approximately 528 single-family dwellings, 11 business and commercial establishments (including one marina), one motel, and one fire station. Of the 528 dwellings, 150 are permanent residences and 378 are second or weekend homes. It is proposed that there will ultimately be 1,722 single-family dwellings, 32 business and commercial establishments, three churches, one marina, and one motel, in addition to other facilities which will comprise the community.

All information concerning the district, including population projections, were obtained from a preliminary engineering report for the district prepared by Bryant-Currington, Inc., and Freese, Nichols & Endress, Inc., Consulting Engineers, dated September, 1972. Using a factor of 3.5 persons per dwelling and a proposed development phasing, the engineers for the District derived the following population projections:

Population Projections

	1972	1979	1992
Population Equivalent	1,890	3,402	6,173

Ultimate development of the area is expected by 1992. Assuming a design criteria for sewage treatment facilities of 100 gpcd, the following flows are obtained:

Wastewater Flows

	1972	1979	1992
Average Flow, gpd	189,000	340,200	617,300

For design purposes, the engineers for the District rounded out the 1979 projected average flow to 0.35 mgd and the 1992 projected average flow to 0.625 mgd. Advanced treatment facilities were also prosed for the Sunrise Beach MUD No. 1 in addition to secondary facilities, as it was reported there is no land available for disposal of effluent due to adverse soil conditions.

No sewage collection system was proposed in the preliminary engineering report, and no plans were available from the engineers for the District at the time this report was prepared. For the purpose of cost estimation, a proposed sewerage system to serve the District is presented on Plate HL-7. The estimated cost for these proposed collection system improvements is $947,200.

In order that the proposed wastewater treatment improvements for Sunrise Beach be consistent with those for the other communities adjacent to the Highland Lakes, tertiary treatment by means of filtration rather than chemical treatment should be employed. Therefore, it is recommended that by 1975 Sunrise Beach construct conventional secondary treatment facilities and a filtration plant having an initial design capacity of 0.35 mgd. The estimated cost for these 1975 improvements is $336,000. This capacity would be adequate until about 1980, at which time an expansion to the proposed secondary and tertiary facilities having a design capacity of 0.275 mgd would be adequate throughout the study period. The estimated cost for these 1980 improvements is $286,000. An additional $100,700 would also be required for lift stations by 1980. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $330,000.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should Sunrise Beach wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $431,900.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $55,000.

Dry Creek Area.

The Dry Creek area is located on the east side of Lake LBJ across the lake from Sunrise Beach MUD No. 1 and north of the Sherwood Shores area at the confluence of Dry Creek and Station Creek with Lake LBJ. The area was presented as Area 2 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	599	777	886	1,204	1,500

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-7 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $314,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.10 mgd. The cost of the 0.10 mgd secondary treatment facility and filtration plant is estimated to be $147,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $158,800.

To meet the wastewater treatment requirements for an increasing population, a 0.05 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.05 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $118,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Dry Creek area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.10 mgd conventional secondary treatment facility at an approximate capital cost of $121,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $90,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Sherwood Shores - Granite Shoals Area

The Sherwood Shores area, which includes the incorported City of Granite Shoals, was presented as Area 1 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. The population projections for the entire area from 1970 through 1990, as given in the Highland Lakes Report, including a projection for year 2020 are given below. Population projections for the City of Granite Shoals as shown were supplied by the TWDB. The difference between these figures and the totals for the entire area are assumed to represent the remaining Sherwood Shores area.

Population Projections

Year	1970	1985	1980	1990	2020
Population					
Granite Shoals	342	336	330	330	320
Sherwood Shores	2,723	3,159	4,262	5,895	7,680
Total Area	3,065	3,495	4,592	6,225	8,000

Although the population of Granite Shoals is projected to decrease slightly over the study period, the entire area is expected to almost triple in population by year 2020.

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-7 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $3,401,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.55 mgd. The cost of the 0.55 mgd secondary treatment facility and filtration plant is estimated to be $469,300. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $320,000.

To meet the wastewater treatment requirements for an increasing population, a 0.25 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.25 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $481,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Sherwood Shores - Granite Shoals area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.55 mgd conventional secondary treatment facility at an approximate capital cost of $394,000.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $450,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Backbone Mountain - South Area

This area is located just south of Backbone Mountain adjacent to the east side of Lake LBJ between the lake and F.M. 1431. The area was presented as Areas 3 and 4 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	711	788	879	1,170	1,300

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $241,700. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.10 mgd. The cost of the 0.10 mgd secondary treatment facility and filtration plant is estimated to be $147,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $158,800.

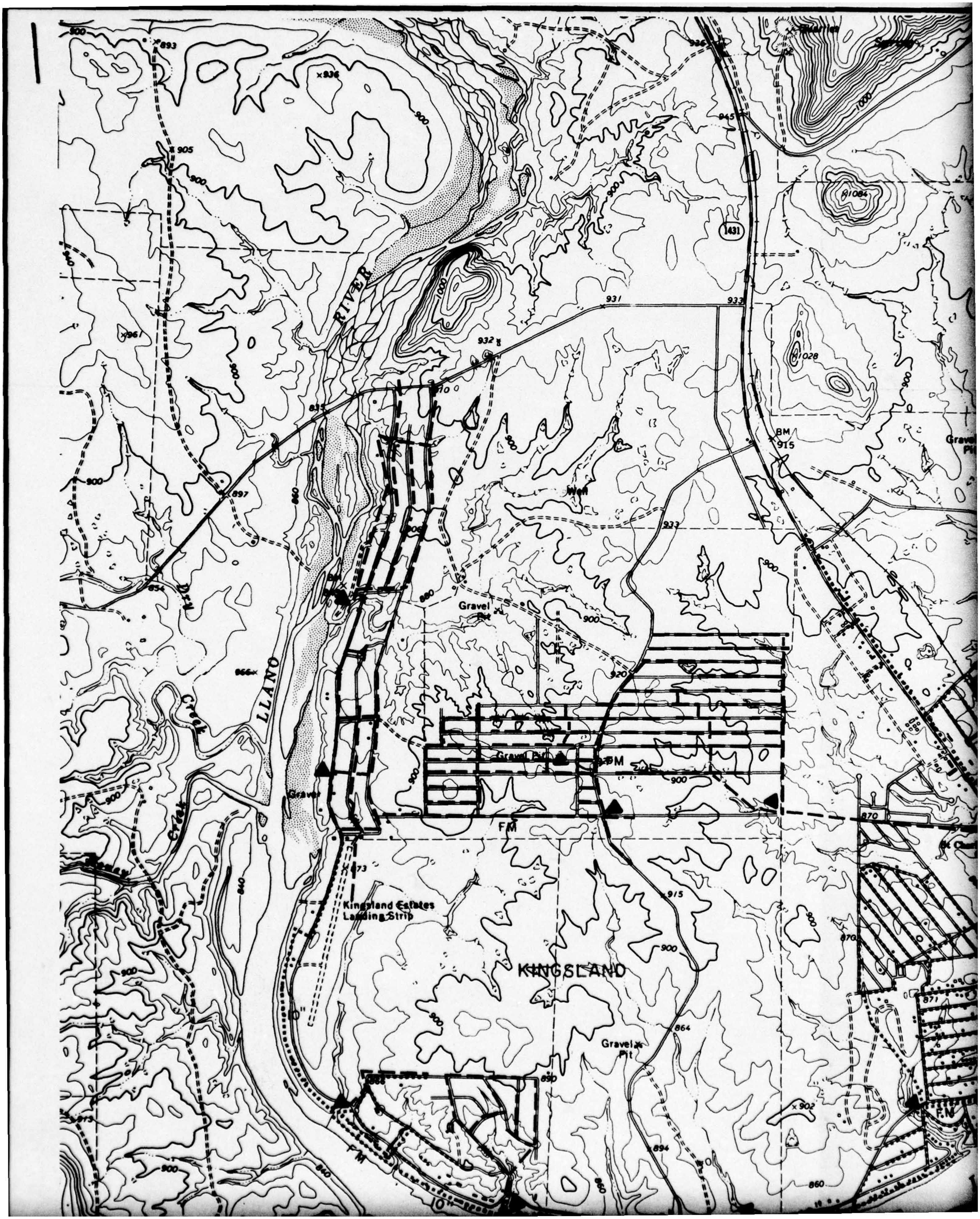
To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $83,600.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Backbone Mountain - South Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.10 mgd conventional secondary treatment facility at an approximate capital cost of $121,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $90,000.

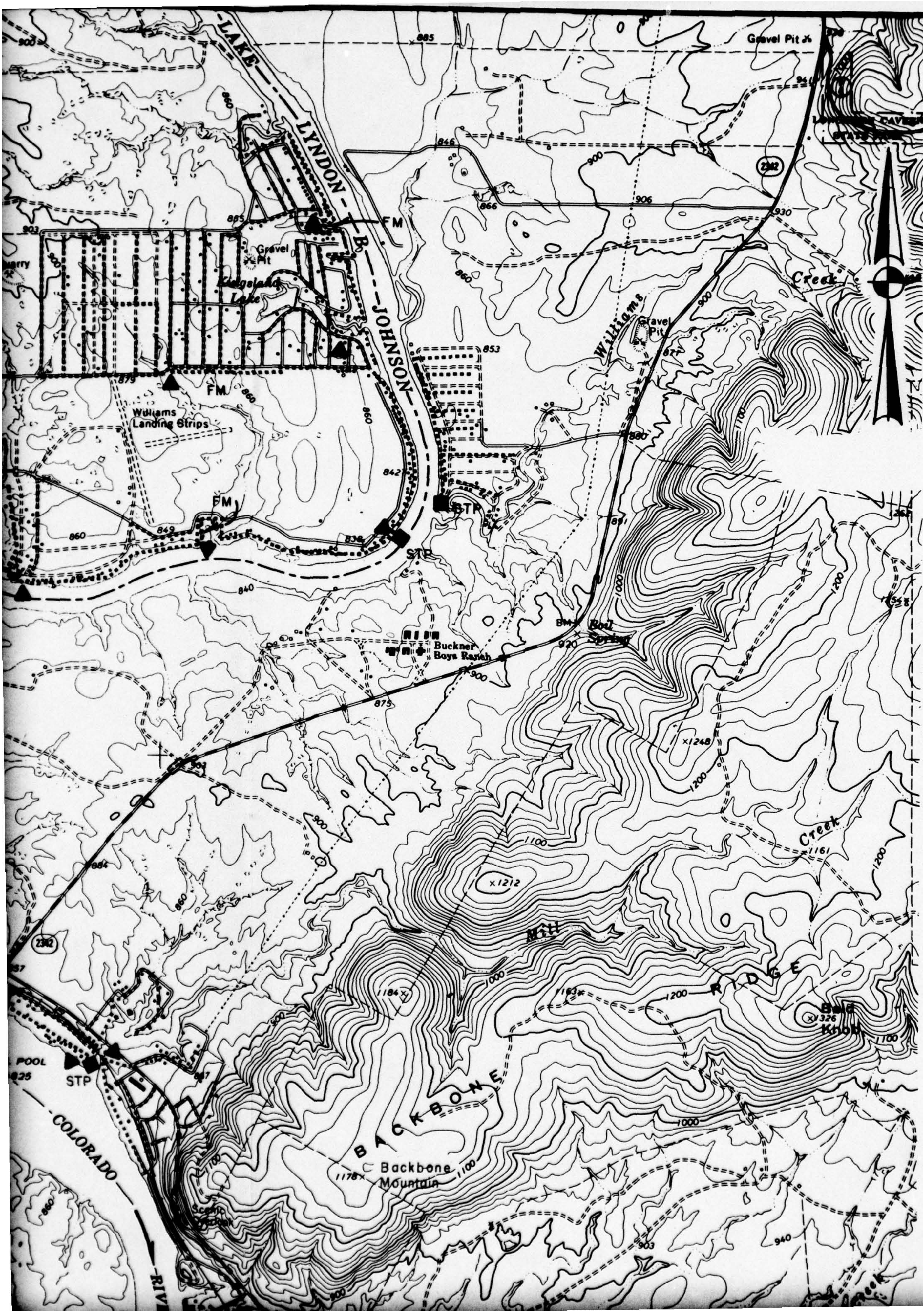
This no-discharge plan would require phased capacity expansions as presented in the discharge plan.



LLANO
RIVER
KINGSLAND
Kingsland Estates
Landing Strip
Gravel Pit
Gravel Pit
Gravel Pit
Gravel
Well
Dry
Creek
Creek
FM
FM
FM
BM 915
1431
1000
1000
900
933
931
932
945
936
905
893
897
854
866
961
873
915
864
894
902
860
870
871
850

LAKE
LYNDON
B
JOHNSON
FM
Gravel Pit
Quarry
Kingsland Lake
Williams Landing Strips
Kingsland Cem
LLANO CO
BURNET CO
STP
Buckner Boys
Gravel Pit
St Charles Ch
Kingsland
BM
2342
City Park
NORMAL POOL ELEV 825
COLORADO
Backbone Mountain
Scenic Overlook
Ferry
Haywood Memorial Ch
LYNDON
B
JOHNSON

3


LAKE
LYNDON
B.
JOHNSON
Gravel Pit
Gravel Pit
Kingsland Lake
FM
FM
FM
Williams Landing Strips
STP
STP
STP
Williams
Gravel Pit
Creek
Buckner Boys Ranch
Boil Spring
Creek
Mill
RIDGE
BACKBONE
Backbone Mountain
Bald Knob
COLORADO
POOL
2342
2342
885
846
866
906
930
900
903
879
853
860
842
849
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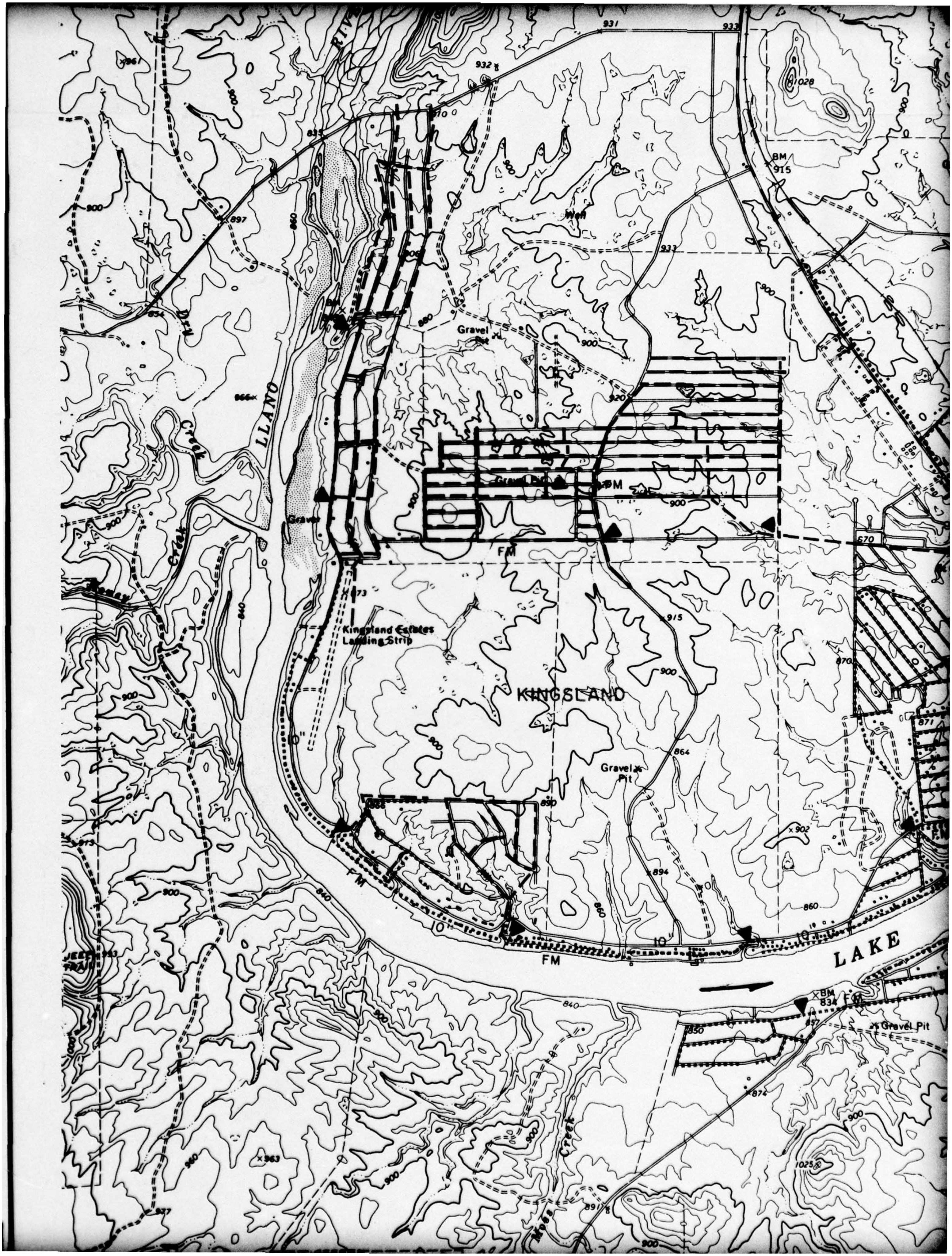
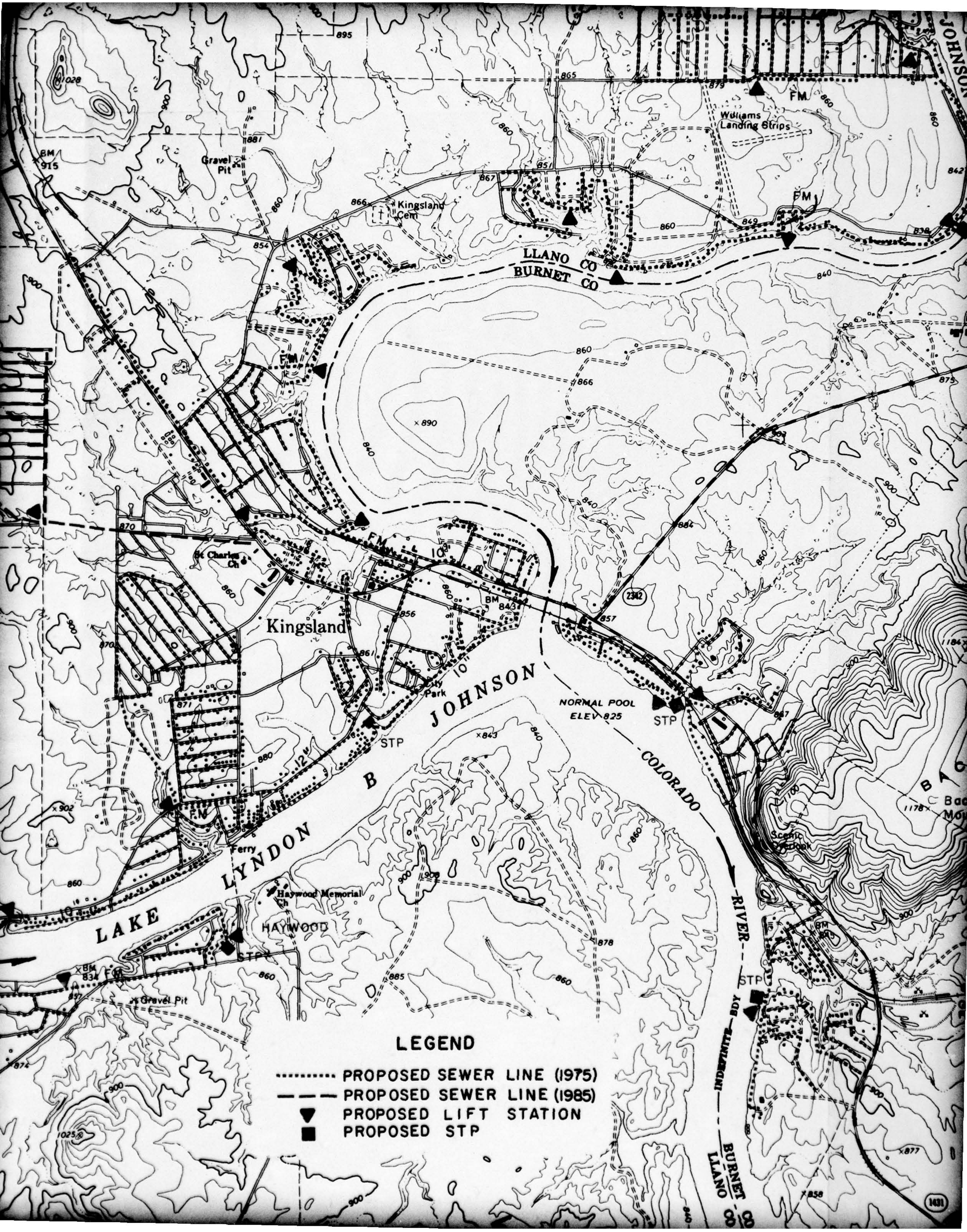
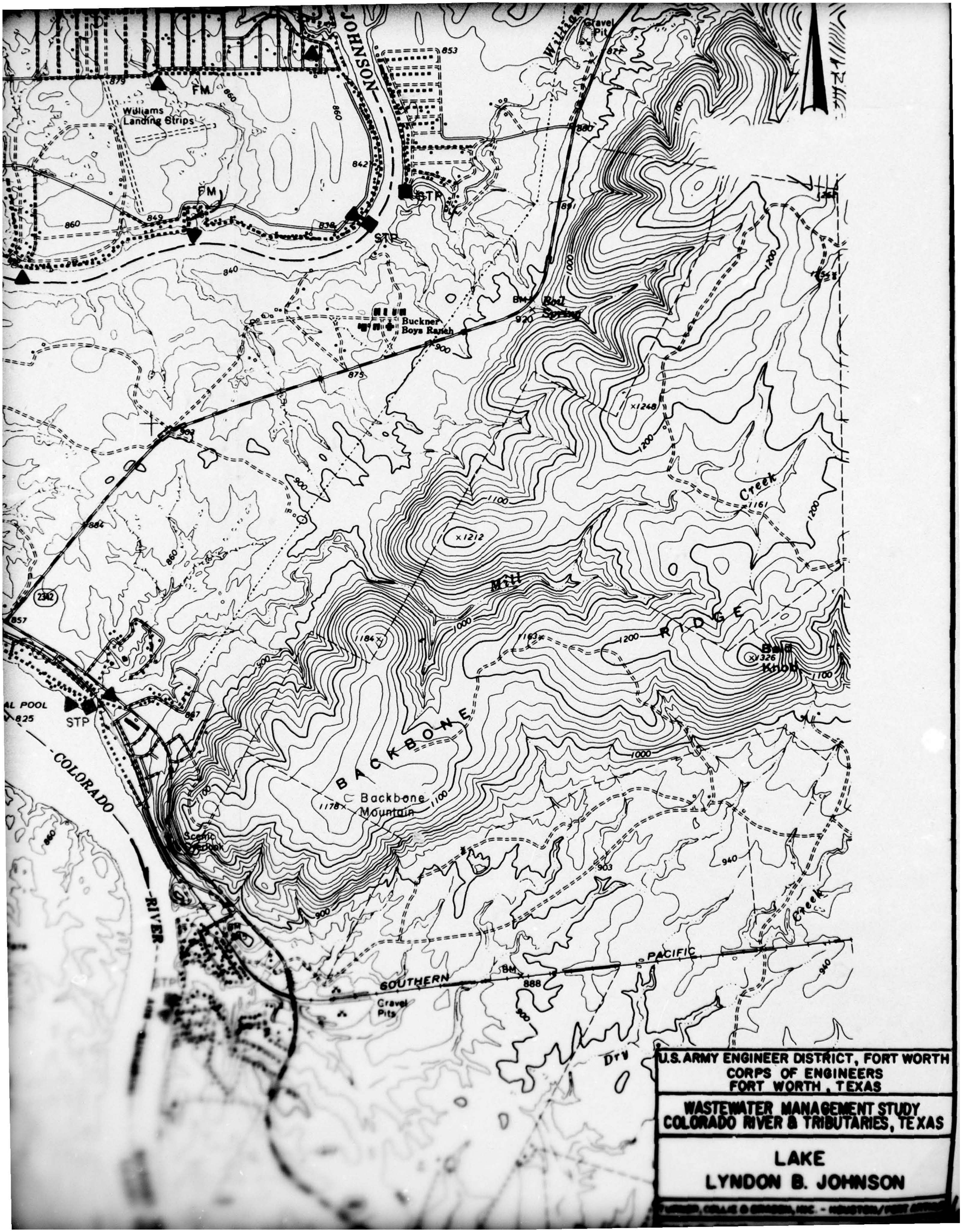
940



LLANO
RIVER
Dry
Creek
KINGSLAND
Kingsland Estates
Landing Strip
Gravel Pit
Gravel
Well
BM
915
FM
LAKE
Moss Creek
Gravel Pit
JEEP TRAIL
931
933
932
1028
897
900
866
873
915
864
890
902
894
860
840
850
857
834
874
1025
963
937
871
870
670



LEGEND
PROPOSED SEWER LINE (1975)
PROPOSED SEWER LINE (1985)
PROPOSED LIFT STATION
PROPOSED STP
Kingsland
LAKE LYNDON B JOHNSON
COLORADO RIVER
LLANO CO
BURNET CO
Kingsland Cem
Gravel Pit
St Charles Ch
City Park
NORMAL POOL ELEV 825
STP
FM
Ferry
Haywood Memorial Ch
HAYWOOD
Williams Landing Strips
Scenic Overlook
INDEFINITE BDY



JOHNSON
Gravel Pit
853
879
FM
860
Williams Landing Strips
842
STP
FM
849
838
860
STP
840
Buckner Boys Ranch
BM
920
900
875
907
900
×1248
1200
Creek
1161
1100
×1212
884
860
2342
Mill
1000
RIDGE
1200
Bald Knob
×1326
1100
857
1184×
1163×
AL POOL
825
STP
BACKBONE
COLORADO
1000
Backbone Mountain
1178×
1100
Scenic Overlook
860
900
903
940
Creek
RIVER
PACIFIC
SOUTHERN
BM
888
940
Gravel Pits
900
Dry
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAKE
LYNDON B. JOHNSON

Backbone Mountain - North Area

This area is located just northwest of Backbone Mountain adjacent to the east side of Lake LBJ and on both sides of F.M. 1431 which bisects the area. The area was presented as Areas 5 and 6 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	410	511	613	823	1,030

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $252,200. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.07 mgd. The cost of the 0.07 mgd secondary treatment facility and filtration plant is estimated to be $112,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $137,800.

To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $91,200.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Backbone Mountain - North Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.07 mgd conventional secondary treatment facility at an approximate capital cost of $91,700.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $63,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Williams Creek Area

This area is located on the east side of Lake LBJ at the confluence of Williams Creek with the lake, between F.M. 2342 and Lake LBJ. The area was presented as Area 7 on Lake LBJ under Plan A, Sub-Area 3

in the Phase III Highland Lakes Report. The population projections for the area from the 1970 through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	224	315	420	560	700

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $120,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.07 mgd. The cost of the 0.07 mgd secondary treatment facility and filtration plant is estimated to be $112,000. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $137,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Williams Creek area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.07 mgd conventional secondary treatment facility at an approximate capital cost of $91,700.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $63,000.

Haywood Area.

The Haywood area is located along the south bank of the Llano River approximately 10,000 feet above the confluence of the river with Lake LBJ and the Colorado River. This area was presented as Area 12 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	105	175	245	350	500

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed by 1975. The cost of

the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $184,100. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.03 mgd. The cost of the 0.03 mgd secondary treatment facility and filtration plant is estimated to be $69,900. This initial design capacity would be adequate until 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $104,400.

To meet the wastewater treatment requirements for an increasing population, a 0.02 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.02 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $80,600.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Haywood area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.03 mgd conventional secondary treatment facility at an approximate capital cost of $55,400.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $27,500.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Kingsland Area.

The Kingsland area is located between the north and east sides of the Llano River and the west side of Lake LBJ and the Colorado River at the confluence of the Llano River with Lake LBJ, in Llano County. The area was presented as Area 11 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	2,839	3,077	3,329	3,742	4,650

The Kingsland area is served by the Kingsland Water Department which provides water to approximately 428 customers at present. Raw water is pumped from the Llano River at a point about 1/2 mile upstream from its confluence with the Colorado River and to a water treatment plant. The capacity of the water treatment plant is reported to be adequate to serve approximately 1,000 connections on a basis of 3,500 gallons per customer per month on a yearly average.

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed in two phases. The cost of the 1975 proposed collection system, including lift stations and engineering and contingencies, is estimated to be $2,113,000. The second phase of the proposed collection system would be constructed by 1985, as development expands into new areas. The cost of this 1985 proposed collection system, including lift stations and engineering and contingencies, is estimated to be $1,423,000. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.465 mgd. The cost of the 0.465 mgd secondary treatment facility and filtration plant is estimated to be $429,120. this initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $299,000.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Kingsland area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.465 mgd conventional secondary treatment facility at an approximate capital cost of $358,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $410,000.

Kingsland Lake Area.

The Kingsland Lake area is located along the west side of Lake LBJ northeast of the Kingsland area. The area was presented as Area 10 on Lake LBJ under Plan A, Sub-Area 3, in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	1,079	1,198	1,296	1,443	1,500

A portion of the area is served by the Kingsland Water Department described in the discussion for the Kingsland area.

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-8 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $884,700. It is also proposed that

a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.15 mgd. The cost of the 0.15 mgd secondary treatment facility and filtration plant is estimated to be $191,000. This initial design capacity would be adequate throughout the study period. By 1985, the Kingsland Lake Area will neet to construct additional lift stations capacity at an estimated project cost of $55,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Kingsland Lake area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.15 mgd conventional secondary treatment facility at an approximate capital cost of $158,000.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $130,000.

Hoovers Valley Area.

The Hoovers Valley area is located on the east side of Lake LBJ approximately 5,000 feet downstream from Roy Inks Dam, and at the southwest corner of Inks Lake State Park. The area was presented as Area HL-8 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below, along with a projection for year 2020.

Population Projections

Year	1980	1975	1980	1990	2020
Population	95	140	147	245	475

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the first phase of the proposed collection system as shown on Plate HL-9, be constructed by 1975. The cost of the 1975 proposed collection system, including lift stations and engineering and contingencies, is estimated to be $251,200. The second phase of the collection system would be constructed by 1985 at an estimated cost of $235,800, including engineering and contingencies. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.02 mgd. The cost of the 0.02 mgd secondary treatment facility and filtration plant is estimated to be $57,810. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $91,400.

To meet the wastewater treatment requirements for an increasing population, a 0.025 mgd expansion of the facilities would be required by 1985,

and would be adequate until the year 2020. The estimated cost for this 0.025 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $67,000.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Hoovers Valley Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.02 mgd conventional secondary treatment facility at an approximate capital cost of $44,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $18,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Murchison Area.

The Murchison area is located on the west side of Lake LBJ directly across the lake from the Hoovers Valley area. The area was presented as Area 9 on Lake LBJ under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

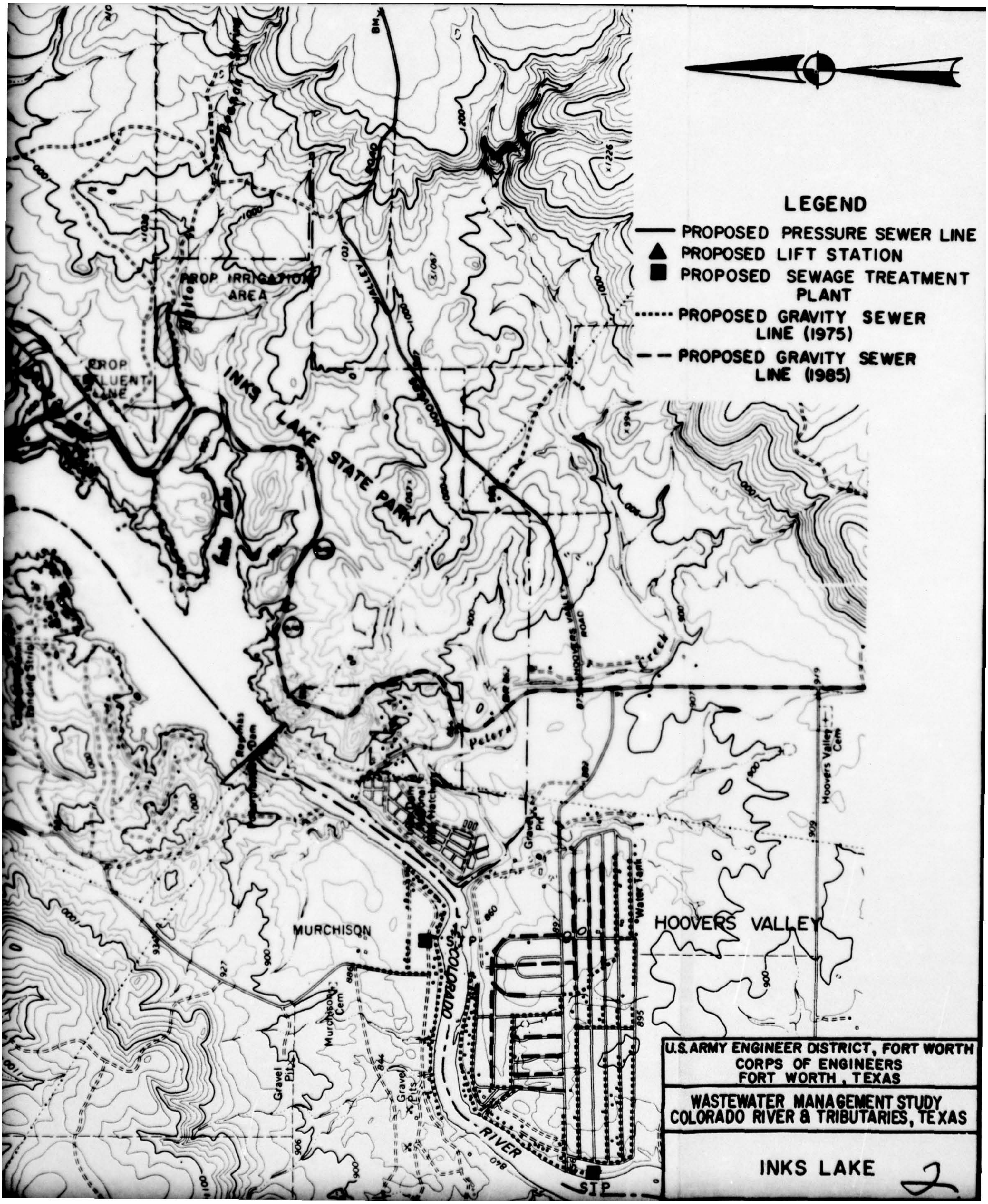
Population Projections

Year	1980	1975	1980	1990	2020
Population	161	168	175	210	250

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-9 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $104,900. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.025 mgd. The cost of the 0.025 mgd secondary treatment facility and filtration plant is estimated to be $63,960. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $96,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Murchison area wish to implement a no-discharge plan, the following items would be required:

INKS LAKE STATE PARK
PROP IRRIGATION AREA
PROP EFFLUENT LINE
COLORADO
LAKE
INKS
COLORADO RIVER
S T P
BURNET CO
LLANO CO
MURCHISON
Murchison Cem
Gravel Pits
Golf Course
Pier
Water Tank
RIVER
Lake



LEGEND
PROPOSED PRESSURE SEWER LINE
PROPOSED LIFT STATION
PROPOSED SEWAGE TREATMENT PLANT
PROPOSED GRAVITY SEWER LINE (1975)
PROPOSED GRAVITY SEWER LINE (1985)
PROP IRRIGATION AREA
PROP EFFLUENT LINE
INKS LAKE STATE PARK
HOOVERS VALLEY ROAD
MURCHISON
HOOVERS VALLEY
COLORADO RIVER
Murchison Cem
Hoovers Valley Cem
Gravel Pits
STP
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
INKS LAKE
2

1. By 1977, construct a 0.025 mgd conventional secondary treatment facility at an approximate capital cost of $49,400.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $23,000.

Inks Lake Area
(Plates HL-9 and HL-10)

Introduction.

Inks Lake, the shortest of the Highland Lakes, is located on the boundary between Burnet and Llano Counties between Lake Lyndon B. Johnson and Lake Buchanan. Being the smallest of the Highland Lakes, it also has the least amount of development along its shores. The number of houses by permanent and temporary categories, adjacent to the Lake, projected from 1970 to 1990 as given in the Highland Lakes Report, is shown below.

	Number of Houses				
Inks Lake	1970	1975	1980	1985	1990
East Side (Burnet County)					
Permanent	66	78	103	124	150
Temporary	32	45	46	50	50
West Side (Llano County)					
Permanent	28	40	54	69	86
Temporary	24	31	37	42	46

There are slightly more permanent houses than temporary at the present time with the projection that there will be twice as many permanent homes than temporary by 1990.

The soils surrounding Inks Lake are of two general types. Those along the west or Llano County side are of the Tishomingo Gravelly association, as described in the discussion for the soils around Lake Marble Falls. The east side or Burnet County side of the lake is made up of the Tishomingo Gravelly-Rough Rocky Land association, also described in the Lake Marble Falls discussion. These soils are characterized by either a thin surface layer underlain by granite or gneiss, or outcrops of bedrock having no soil covering. Where soils exist, their permeability is moderately low (0.20 to 0.63 inch per hour). The soils on both sides of the lake are gently sloping ranging from 1 to 5 percent.

Although there is a potential for using the overland runoff method of tertiary treatment in this area, delineating the exact location of a tract of land would require an onsite inspection of a considerable amount of lakeshore. Therefore, for the purpose of this study, filtration as a means of tertiary treatment will be recommended. It should be noted that if a suitable tract of land can be found for this purpose on a permanent basis, land disposal may be substituted for filtration of the secondary effluent.

Water supply to residents of the area consists of individual wells.

Inks Lake State Park

Inks Lake State Park is located along the east shore of Lakes LBJ and Inks in Burnet County. The park consists of approximately 1,200 acres and provides facilities for camping, picnicking, fishing, swimming and boating. Also included within the park area just below Roy Inks Dam is the Inks Dam National Fish Hatchery.

At the time this report was prepared, the Department of Parks Land Planning of the Texas Parks and Wildlife Department was preparing a preliminary engineering study for the construction of a sewage collection and treatment system to allow abandonment of septic tank areas within the park.

The preliminary collection system is shown on Plate HL-9 and will consist of a pressure sewer line system utilizing "grinder pump" type lift stations. Also proposed is an 80,000 gallon per day activated sludge sewage treatment plant. As shown on Plate HL-9, it is proposed to pump the effluent from the secondary treatment plant to a 10-acre tract where it will be used to irrigate vacant park land and receive tertiary treatment by the overland runoff method of land disposal.

No cost estimates for this proposed system are presented here since this will be a State-owned and operated system.

North Inks Lake Area.

This area is located west of Inks Lake State Park on the north side of the Lake between S.H. 29 and the Lake. The area was presented as Areas 16 and 17 on Inks Lake under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	351	431	522	700	900

The area is presently served by septic tanks. Based on the above population, it is recommended that the proposed collection system improvements shown on Plate HL-9 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies is estimated to be $226,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.06 mgd. The cost of the 0.06 mgd secondary treatment facility and filtration plant is estimated to be $105,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $131,800.

To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $108,500.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the North Inks Lake area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.06 mgd conventional secondary treatment facility at an approximate capital cost of $85,700.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $54,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Lake Buchanan Area
(Plates HL-10 through HL-14)

Buchanan Dam was the first of the Highland Lakes Dam to be completed by the LCRA. It is also the longest of the dams, and Lake Buchanan is the widest of the Highland Lakes, although it is second to Lake Travis in terms of size. Lake Buchanan is located on the boundary between Burnet and Llano Counties and is the uppermost in the chain of the Highland Lakes.

The number of houses by permanent and temporary categories along the shores of Lake Buchanan, as given in the Highland Lakes Report, is presented below.

	Number of Houses				
Lake Buchanan	1970	1975	1980	1985	1990
East Side (Burnet County)					
Permanent	129	320	443	580	773
Temporary	488	459	693	802	895
West Side (Llano County)					
Permanent	251	354	517	679	820
Temporary	453	366	353	342	351

From the table, it is seen that there are more temporary houses in existence along the lake than permanent ones. By 1990 it is projected that the east side of the lake will have slightly more temporary than permanent houses but that the west side will consist of more than twice as many permanent ones.

The soils on the east side of Lake Buchanan consist of the Tishomingo Gravelly Soils - Rough Rocky Land and Tarrant-Crawford associations. The Tishomingo and Rough Rocky soils were described in detail in the discussion of the soils surrounding Lake Marble Falls, and the Tarrant-Crawford association was described in detail in the discussion for soils surrounding Lake Travis. Both soils associations are generally characterized by thin surface layers underlain by bedrock of limestone or granite with areas of exposed rock outcrops where soils are non-existent. Where soils exist, their permeability is moderately low, in the 0.20 to 0.63 inch per hour range. Slopes range from nearly level to about 20 percent.

Due to the wide variation of the soil properties, tertiary treatment by means of filtration will be proposed for the Lake Buchanan area. As mentioned previously for the other lakes, if suitable land can be found for one of the land disposal methods of tertiary treatment, this may be substituted for filtration in treating secondary effluent.

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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Water supply for residents of the Lake Buchanan area consists of individual wells and private water supply systems with water treatment plants using lake water as the raw water source.

Buchanan Dam Area.

This area is located at the southern extremity of Lake Buchanan just above the dam and extends along the south and west shore of the lake. The area was presented as Areas 8 and 9 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area as given in the Highland Lakes Report from 1970 through 1990, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	614	645	710	1,300	1,500

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvments shown on Plate HL-10 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $501,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.10 mgd. The cost of the 0.10 mgd secondary treatment facility and filtration plant is estimated to be $147,000. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $158,800.

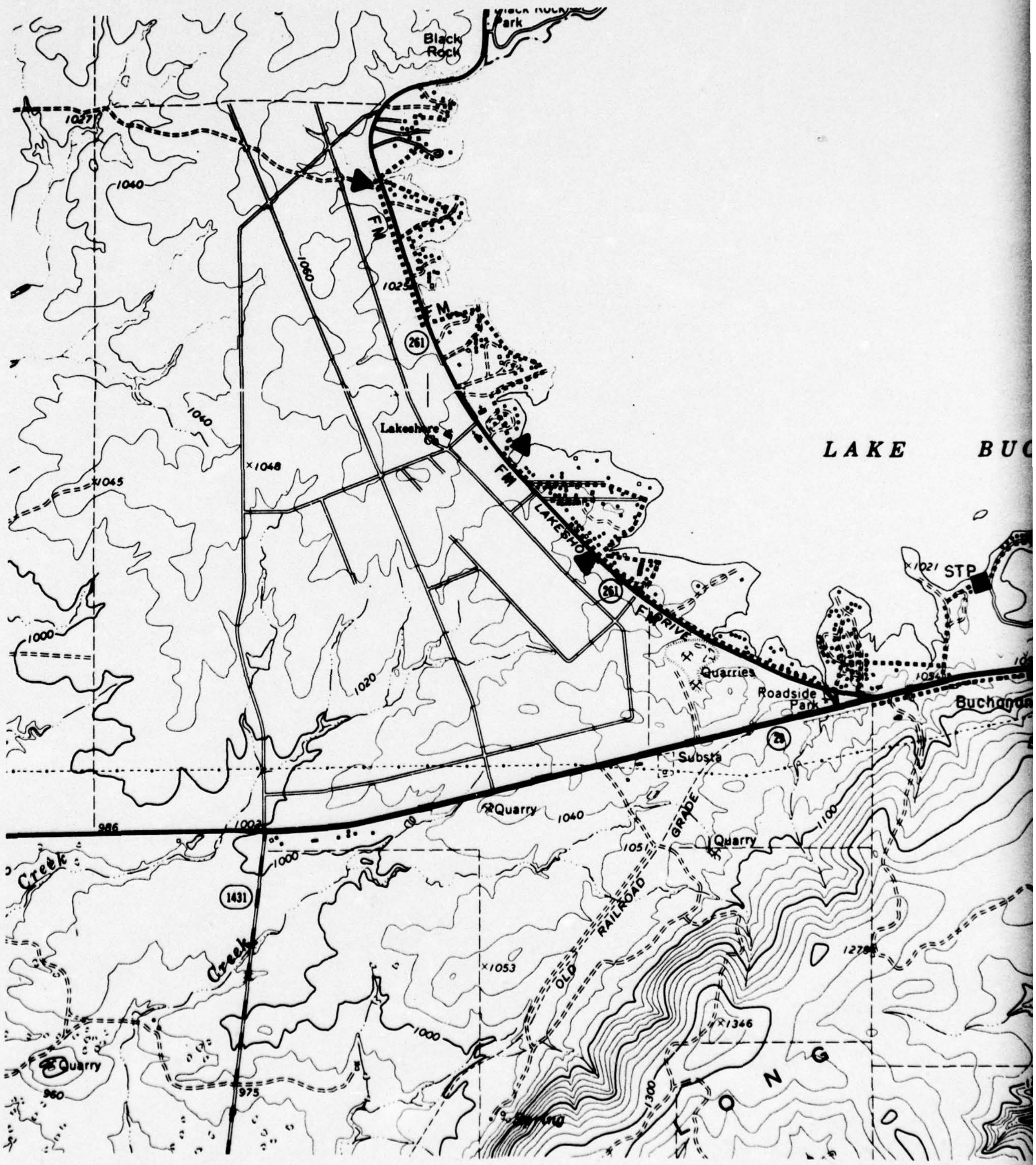
To meet the wastewater treatment requirements for an increasing population, a 0.05 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.05 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $68,400.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Buchanan Dam Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.10 mgd conventional secondary treatment facility at an approximate capital cost of $121,600.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $90,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.



LEGEND

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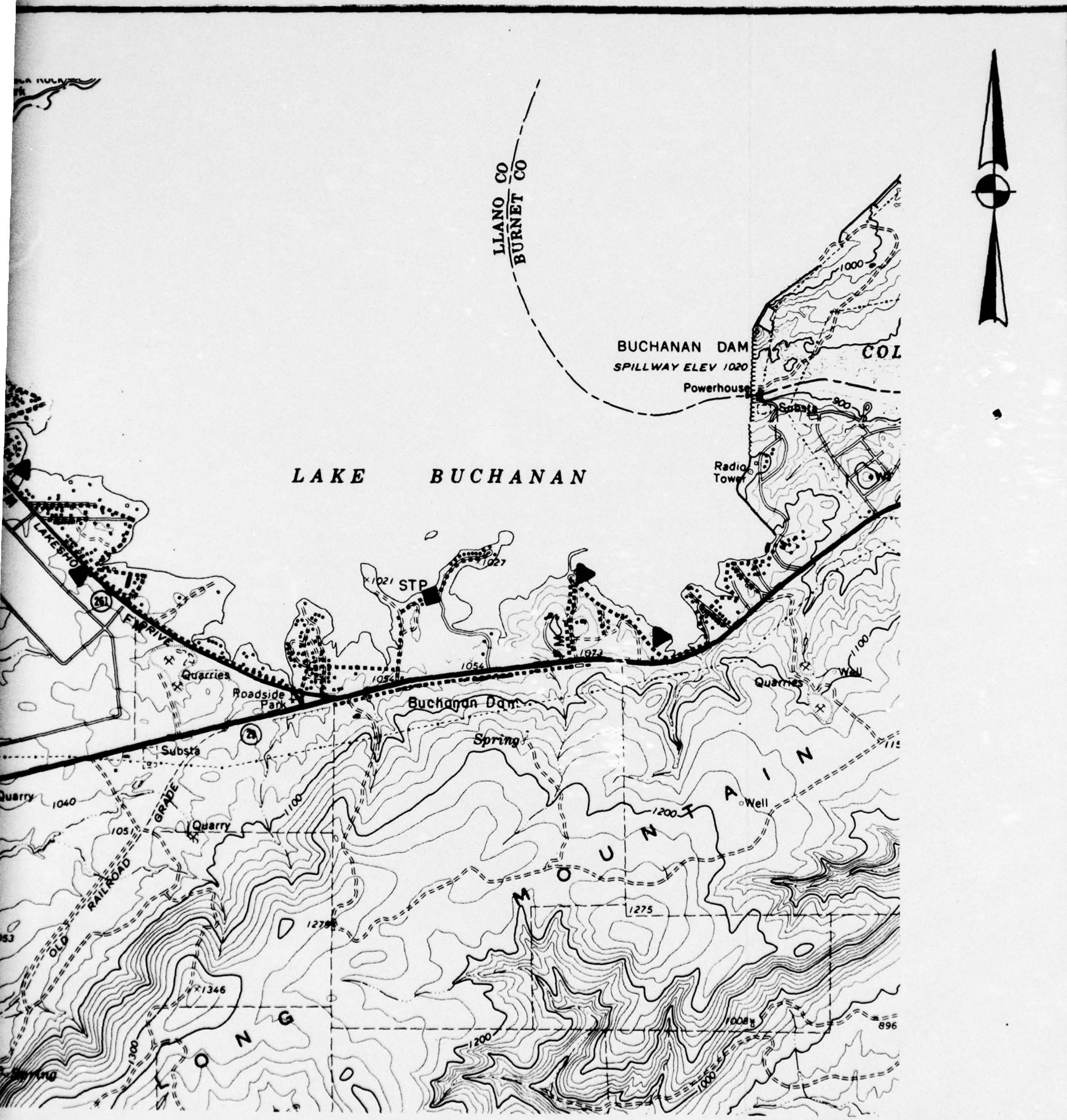
▼ PROPOSED LIFT STATION

■ PROPOSED STP



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CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE BUCHANAN 2

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

Wirth Haven Cove Area

This area is located along the west side of Lake Buchanan between Lakeshore Drive and the Lake. The area was presented as Area 10 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	286	350	550	909	1,200

The area is served by a private water system utilizing lake water as the source for a water treatment plant. Septic tanks are used for the disposal of sewage. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-11 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $282,700. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.08 mgd. The cost of the 0.08 mgd secondary treatment facility and filtration plant is estimated to be $126,460. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $142,800.

To meet the wastewater treatment requirements for an increasing population, a 0.04 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.04 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $122,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Wirth Haven Cove area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.08 mgd conventional secondary treatment facility at an approximate capital cost of $103,700.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $73,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Jeckers Cove Area.

This area is located on the west side of Lake Buchanan between Lakeshore Drive and the lake just north of the Wirth Haven Cove area. The Jeckers Cove area is also served by the private water system which serves the Wirth Haven Cove area. The area was presented as Area 11 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report.

Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are presented below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	130	220	300	500	700

The area is presently served by septic tanks. Based on the above population projections it is recommended that the proposed collection system improvements shown on Plate HL-11 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $225,700. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.04 mgd. The cost of the 0.04 mgd secondary treatment facility and filtration plant is estimated to be $83,200. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $115,300.

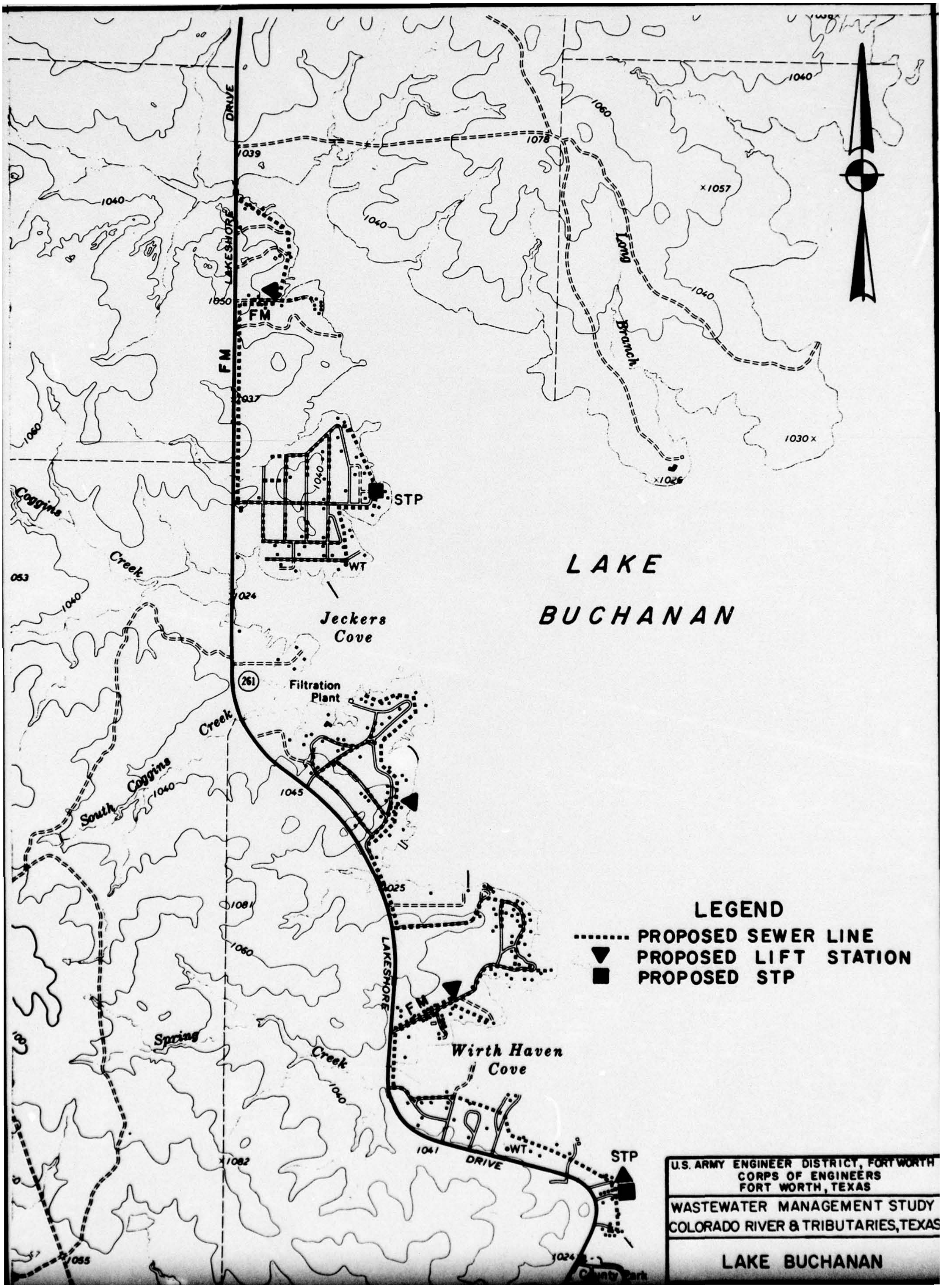
To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $89,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Jeckers Cove area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.04 mgd conventional secondary treatment facility at an approximate capital cost of $67,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $37,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.



LAKE
BUCHANAN
Jeckers
Cove
Wirth Haven
Cove
Filtration
Plant
STP
WT
FM
LAKESHORE
DRIVE
261
Coggins
Creek
South Coggins
Spring
Creek
Long
Branch
County Park
1039
1040
1050
1037
1060
1078
1057
1026
1030
1024
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1025
1081
1082
1041
1055
LEGEND
PROPOSED SEWER LINE
PROPOSED LIFT STATION
PROPOSED STP
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAKE BUCHANAN

Negrohead Area

This area is located along the east side of Lake Buchanan approximately 9,000 feet north of Buchanan Dam and west of Negrohead Mountain. The area was presented as Areas 6 and 7 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	287	424	616	886	1,120

The area is presently served by septic tanks. Based on above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-12 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $259,800. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.08 mgd. The cost of the 0.08 mgd secondary treatment facility and filtration plant is estimated to be $125,250. This initial design capacity would be adequate until about 1986. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $142,800.

To meet the wastewater treatment requirements for an increasing population, a 0.03 mgd expansion of the facilities would be required by 1986, and would be adequate until the year 2020. The estimated cost for this 0.03 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $96,700.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Negrohead Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.08 mgd conventional secondary treatment facility at an approximate capital cost of $103,700.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $73,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Rock Point Area

This area is located adjacent to Rocky Point on the east side of Lake Buchanan. The area was presented as Area 5 on Lake Buchanan under

Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below, along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	63	70	91	130	200

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-12 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $91,000. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.02 mgd. The cost of the 0.02 mgd secondary treatment facility and filtration plant is estimated to be $56,530. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $91,400.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Rocky Point Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.02 mgd conventional secondary treatment facility at an approximate capital cost of $44,500.
2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $18,000.

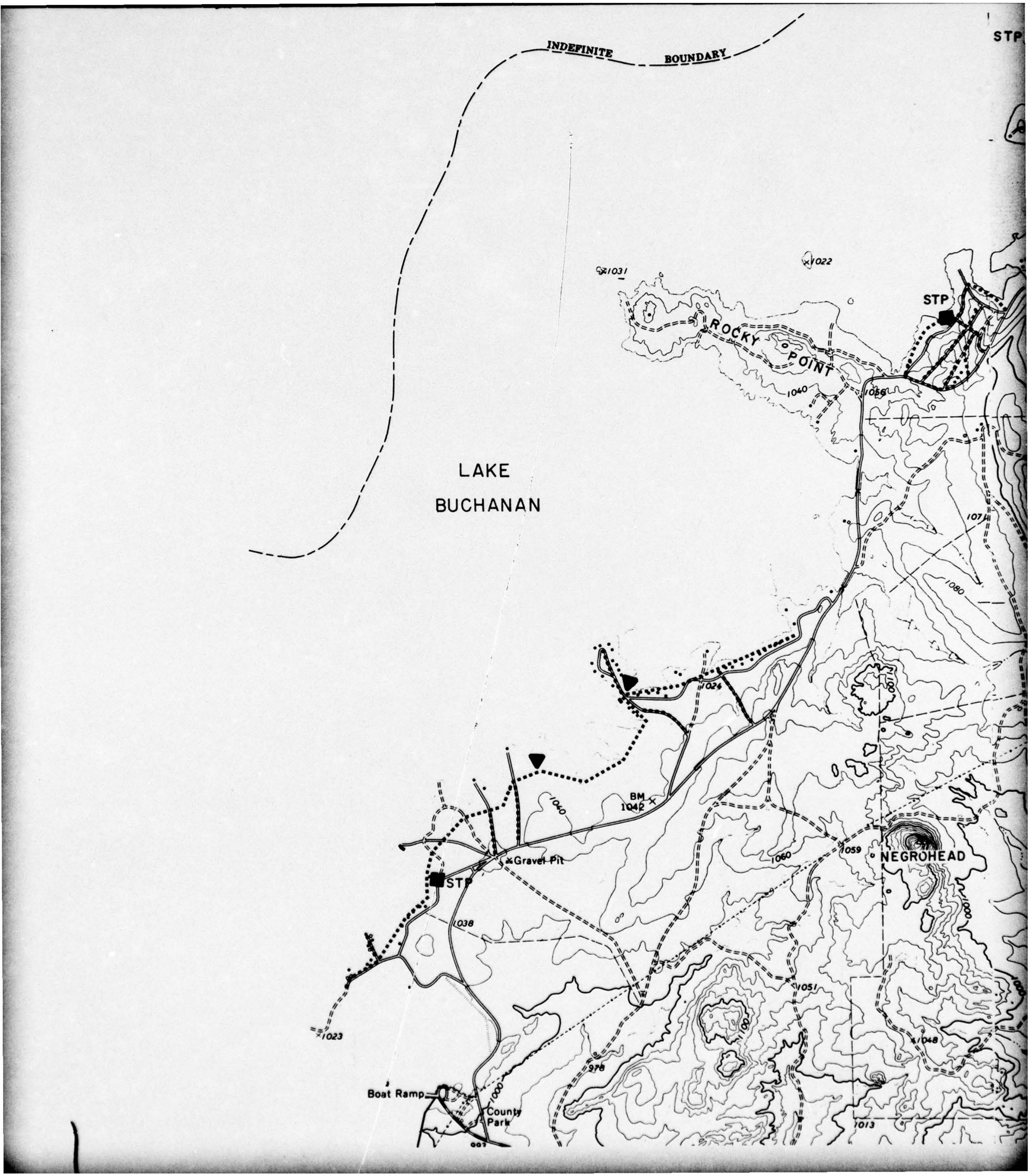
Lion Mountain Area.

This area is located on the east side on Lake Buchanan just west of Lion Mountain. The area was presented as Area 4 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report are presented below along with a projection for year 2020.

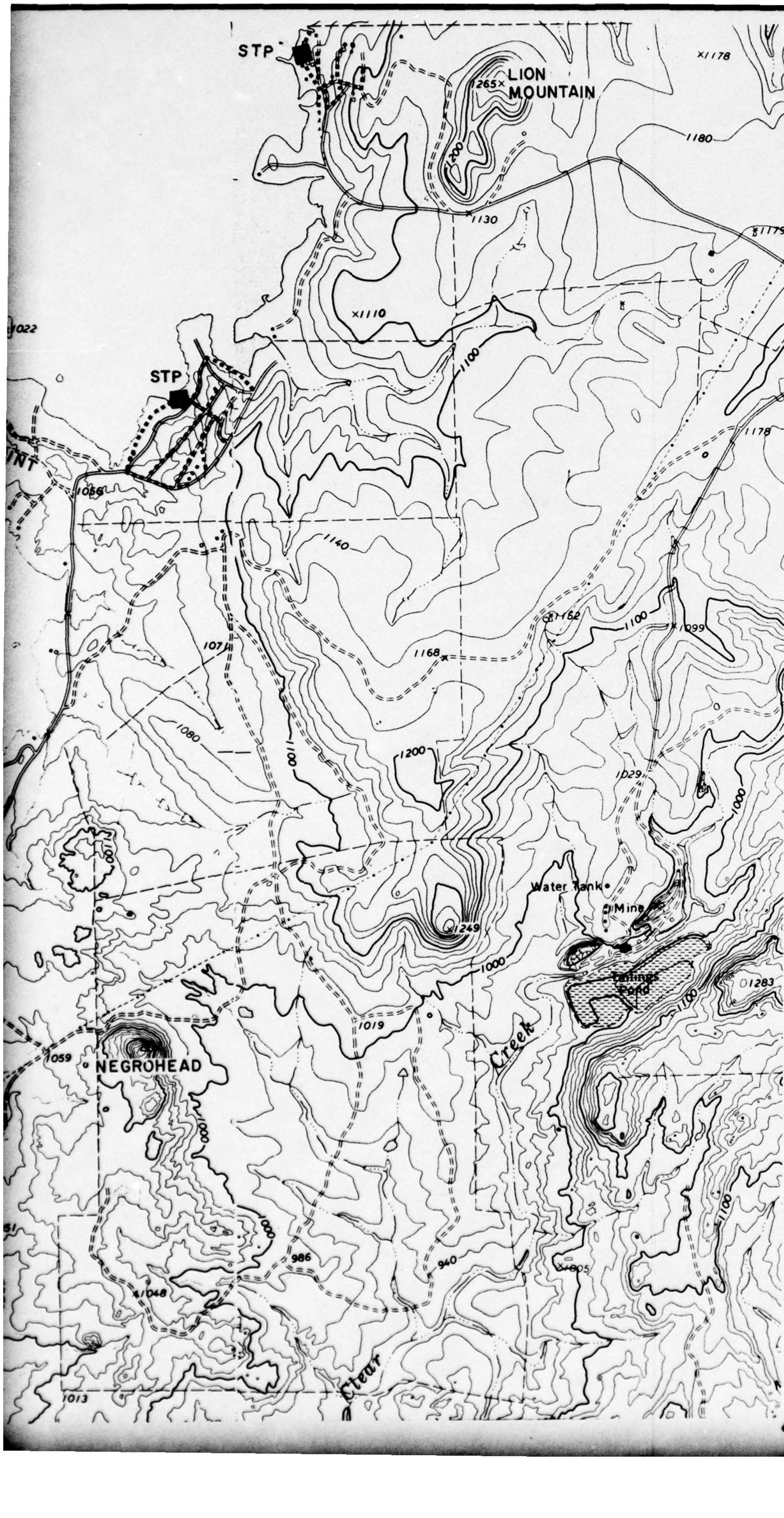
Population Projections

Year	1980	1975	1980	1990	2020
Population	56	71	119	172	225

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-12 be constructed by 1975. The cost of



INDEFINITE BOUNDARY
STP
x1031
x1022
ROCKY POINT
1040
1056
LAKE BUCHANAN
1071
1080
1024
BM 1042
1040
Gravel Pit
STP
1060
1059
NEGROHEAD
1000
1038
1051
x1023
1048
978
Boat Ramp
County Park
1000
1013



LEGEND

- .... PROPOSED SEWER LINE
- ▼ PROPOSED LIFT STATION
- ■ PROPOSED STP

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FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE BUCHANAN

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $72,300. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.0225 mgd. The cost of the 0.0225 mgd secondary treatment facility and filtration plant is estimated to be $60,270. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $93,600.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Lion Mountain area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.0225 mgd conventional secondary treatment facility at an approximate capital cost of $46,930.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $19,500.

Spider Mountain Area.

This area is located at the extreme east side of Lake Buchanan at the mouth of the North Fork of Morgan Creek and adjacent to Spider Mountian. The area was presented as Areas 1 and 2 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	480	711	1,034	1,485	1,850

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-13 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $523,100. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.125 mgd. The cost of the 0.125 mgd secondary treatment facility and filtration plant is estimated to be $168,980. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $178,500.

To meet the wastewater treatment requirements for an increasing population, a 0.06 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this

0.06 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $142,300.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Spider Mountain area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.125 mgd conventional secondary treatment facility at an approximate capital cost of $139,800.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $110,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

White Bluff Area.

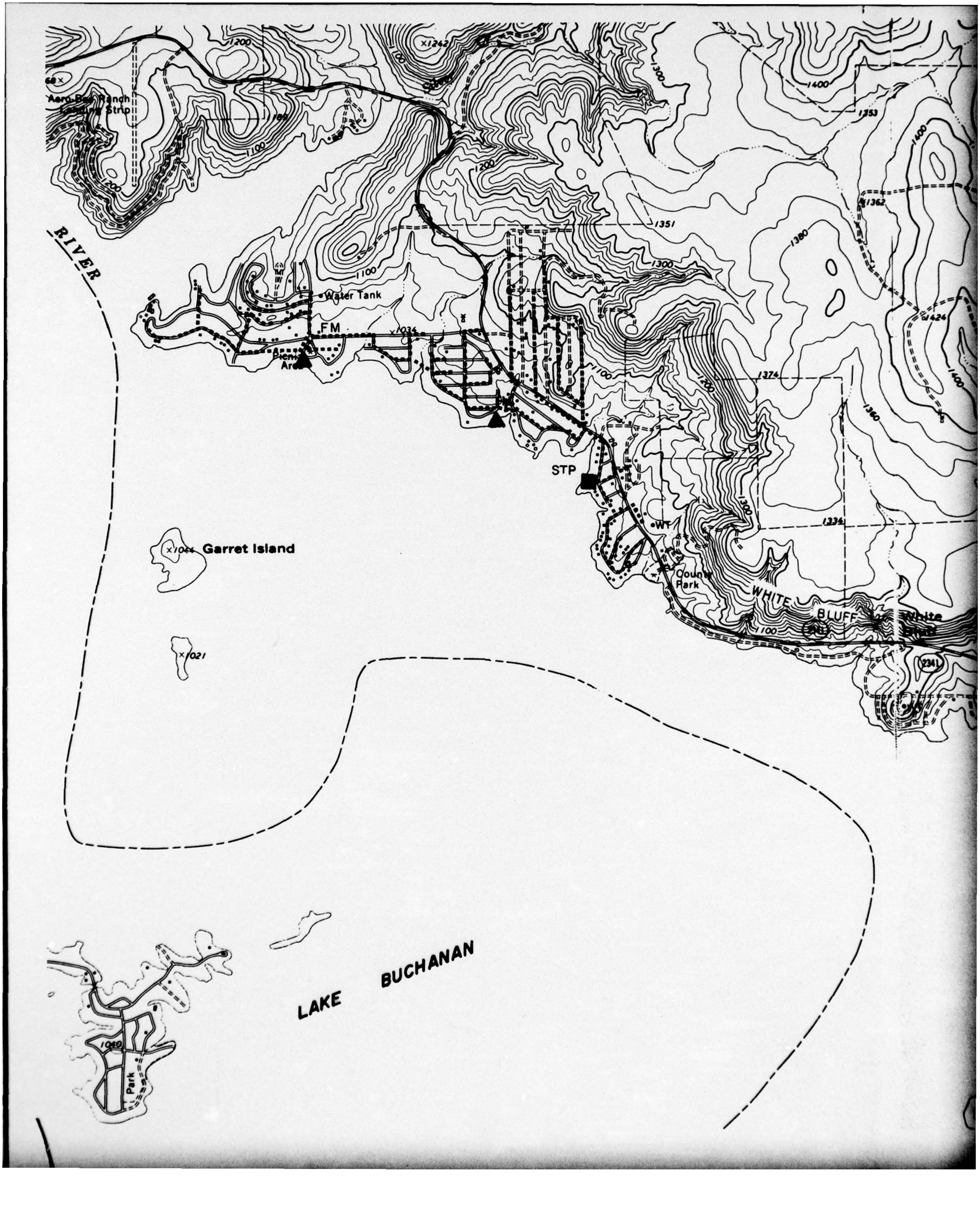
The White Bluff area is located along the northeast side of Lake Buchanan between the mouth of Silver Creek and White Bluff. The area was presented as Area 1 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, along with a projection for year 2020 are given below.

Population Projections

Year	1970	1975	1980	1990	2020
Population	791	1,147	1,712	2,447	3,000

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-13 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $426,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.22 mgd. The cost of the 0.22 mgd secondary treatment facility and filtration plant is estimated to be $247,400. This initial design capacity would be adequate until about 1986. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $213,000.

To meet the wastewater treatment requirements for an increasing population, a 0.08 mgd expansion of the facilities would be required by 1986, and would be adequate until the year 2020. The estimated cost for this 0.08 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $147,700.



Aero Bee Ranch
Landing Strip
RIVER
Water Tank
FM
Picnic
Area
STP
WT
County
Park
WHITE BLUFF
White
Bluff
Garret Island
LAKE BUCHANAN
Park

WHITE BLUFF
White Bluff
2341
Gravel Pit
Rock
North
Fork
Hollow
FM
SPIDER
MOUNTAIN
STP
Well
1480
1400
1353
1362
1368
1453
1417
1300
1380
1424
1360
1374
1200
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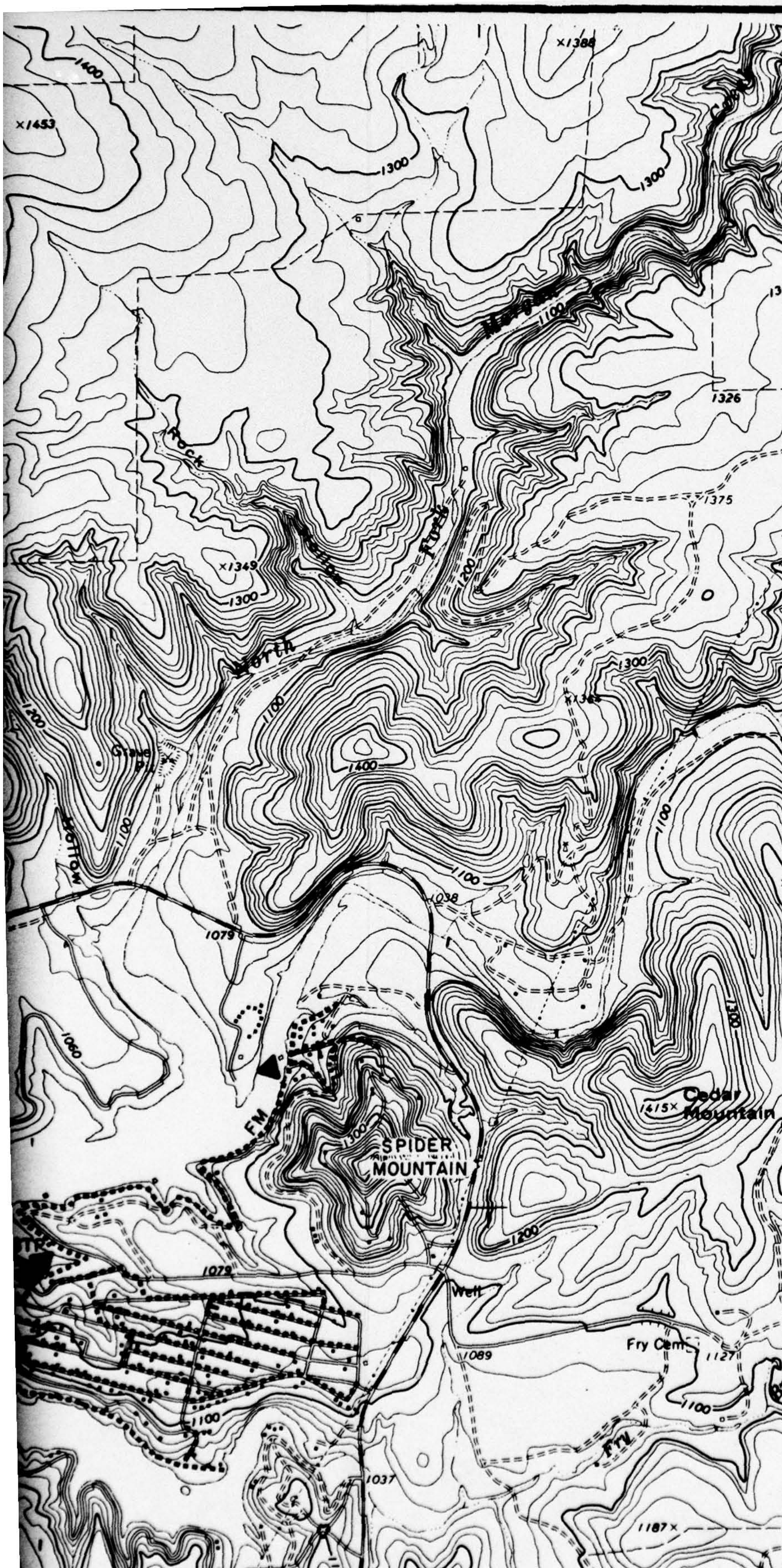

LEGEND

- PROPOSED SEWER LINE
- ▼ PROPOSED LIFT STATION
- ■ PROPOSED STP

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FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAKE BUCHANAN

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the White Bluff Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.22 mgd conventional secondary treatment facility at an approximate capital cost of $204,900.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $190,000.

This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Alexander Branch Area.

This area is located along the west side of Lake Buchanan between Alexander Branch and Maxwells Slough. The area was presented as Area 13 on Lake Buchanan under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990 as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	273	280	288	300	360

The area is presently served by septic tanks. Based on above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-14 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $290,600. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.036 mgd. The cost of the 0.036 mgd secondary treatment facility and filtration plant is estimated to be $77,200. This initial design capacity would be adequate throughout the study period. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $110,000.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Alexander Branch Area wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.036 mgd conventional secondary treatment facility at an approximate capital cost of $61,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $33,000.

Maxwells Slough Area.

The Maxwells Slough area is located on the west side of Lake Buchanan adjacent to the LCRA Park. The area was presented as Area 14 under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with a projection for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	220	350	382	430	600

The area is presently served by septic tanks. Based on the above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-14 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $166,700. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.04 mgd. The cost of the 0.04 mgd secondary treatment facility and filtration plant is estimated to be $83,200. This initial design capacity would be adequate until about 1985. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed at an estimated capital cost of $115,300.

To meet the wastewater treatment requirements for an increasing population, a 0.02 mgd expansion of the facilities would be required by 1985, and would be adequate until the year 2020. The estimated cost for this 0.02 mgd expansion of only the secondary treatment and filtration facilities and lift stations would be $62,900.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the Maxwells Slough area wish to implement a no-discharge plan, the following items would be required:

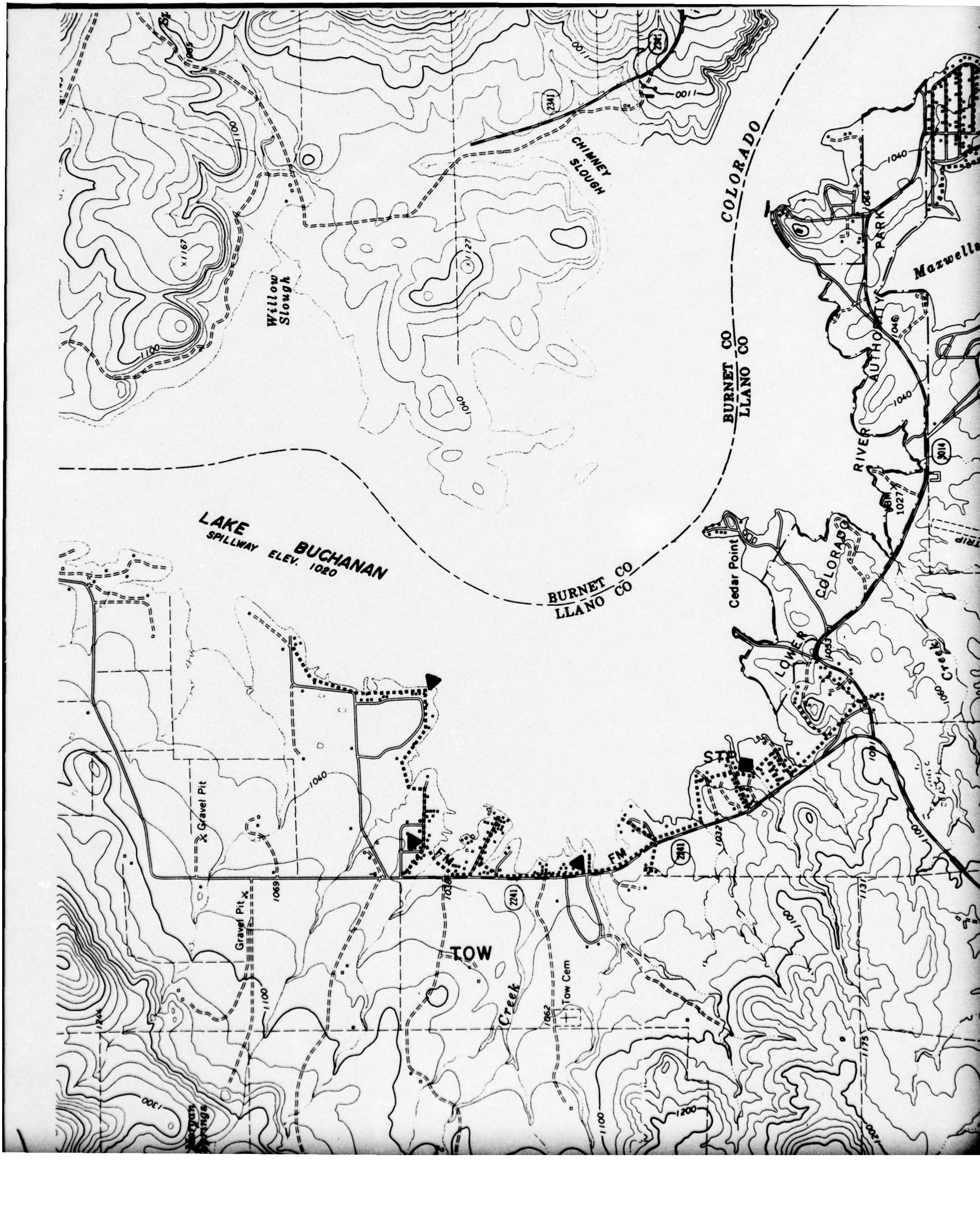
1. By 1977, construct a 0.04 mgd conventional secondary treatment facility at an approximate capital cost of $67,500.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $37,000.

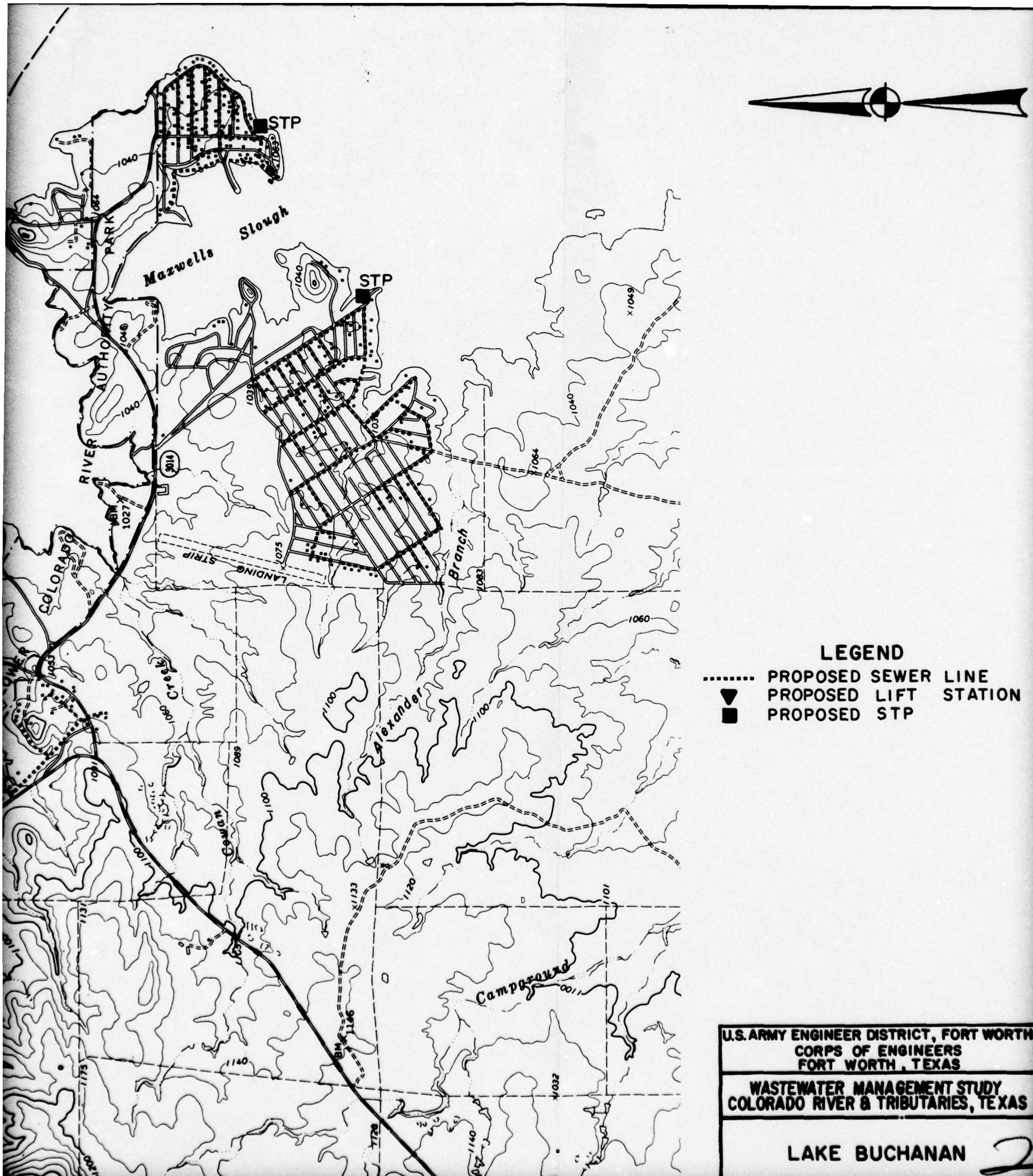
This no-discharge plan would require phased capacity expansions as presented in the discharge plan.

Tow.

The community of Tow is located on the upper west side of Lake Buchanan adjacent to F.M. 2241. The area was presented as Area 15 under Plan A, Sub-Area 3 in the Phase III Highland Lakes Report. Population projections



LAKE BUCHANAN
SPILLWAY ELEV. 1020
BURNET CO
LLANO CO
COLORADO
CHIMNEY SLOUGH
Willow Slough
Cedar Point
LOWER COLORADO RIVER AUTHORITY PARK
Maxwells
STP
FM
2241
2341
3014
Gravel Pit
TOW
Tow Cem
Creek


STP
STP
Maxwells
Slough
RIVER
AUTHORITY
PARK
COLORADO
LANDING STRIP
Alexander
Branch
Creek
Cowan
Campground
3014
LEGEND
PROPOSED SEWER LINE
PROPOSED LIFT STATION
PROPOSED STP
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAKE BUCHANAN 2

for the area from 1970 through 1990, as given in the Highland Lakes Report, are presented below along with projections for year 2020.

Population Projections

Year	1970	1975	1980	1990	2020
Population	388	438	500	600	700

The area is presently served by septic tanks. Based on above population projections, it is recommended that the proposed collection system improvements shown on Plate HL-14 be constructed by 1975. The cost of the proposed collection system, including lift stations and engineering and contingencies, is estimated to be $279,400. It is also proposed that a secondary treatment facility and filtration plant be constructed by 1975, both having an initial design capacity of 0.07 mgd. The cost of the 0.07 mgd secondary treatment facility and filtration plant is estimated to be $110,840. This initial design capacity would be adequate throughout the study period, although an expansion of the lift station is proposed in 1985 at an estimated cost of $18,900. By 1983, nitrification, denitrification and phosphorus reduction facilities should be constructed an at estimated capital cost of $137,800.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be undertaken. However, should the community of Tow wish to implement a no-discharge plan, the following items would be required:

1. By 1977, construct a 0.07 mgd conventional secondary treatment facility at an approximate capital cost of $91,700.

2. By 1983, construct and operate irrigation facilities for disposal of all effluent at an approximate capital cost of $63,000.

NON-METRO PLANS, CAPCO
(AREAS NOT ADJACENT TO THE HIGHLAND LAKES)

Introduction.

This portion of the report presents the areawide plans prepared for cities and communities not adjacent to the Highland Lakes in the CAPCO region which either have existing sewage collection and treatment facilities or for which such facilities are proposed. The counties within the CAPCO region are presented in alphabetical order and the non-metropolitan areas within each county are presented in alphabetical order.

Bastrop, Texas.

The City of Bastrop, an incorporated general law municipality is located in the central portion of Bastrop County at the intersection of S.H. 95, 71, and 21 approximately 28 miles east of Austin, Texas. The incorporated area of the City encompasses 1,500 acres. Bastrop, the county seat of Bastrop County, is under the jurisdiction of the CAPCO.

The City has slight topographic relief - the ground elevations decreaseing about 20 feet in a north to south direction. Drainage is provided by Piney Creek to the north and northwest of town and Gills Creek to the east which flow into the Colorado River which borders Bastrop on the southwest.

The City is underlain by Edge-Tabor and Asa-Bastrop-Lewisville soil types. The Edge-Tabor soil has a fine sandy loam surface, 4 to 12 inches thick, over a very firm, compact, blocky, acid clay grading with depth into a sandy clay. Permeabilities range from 0.63 to 2.0 inches per hour, and the surface soil is crusty and tight when dry. There are severe limitations on septic tanks and very slight limitations on sewage lagoons due to the very low permeability of the underlying clays.

The Asa-Bastrop-Lewisville soil type has a friable, neutral to weakly alkaline, silt loam to silty clay loam surface, generally 10 to 30 inches thick, over a friable, porous, calcareous, silt loam to silty clay loam soil. Permeabilities range 0.63 to 2.0 inches per hour. Septic tanks have slight to severe limitations, and sewage lagoons have moderate to severe limitations due to the hazard of flooding.

Population data, developed by the TWDB for use in this study, indicate that a moderate increase in population is anticipated for Bastrop over the next 50 years. The population estimates are as follows:

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Population Projections

Year	1970	1980	1990	2020
Population	3,112	3,470	3,930	5,210

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central area of the City. In addition to the central business community commercial development has occurred along S.H. 71 west of the Colorado River and is expected to continue. These units consist of light and heavy commercial shops and tourism-related services. The municipal economic resource base is primarily agricultural with some contribution from industry in the form of several light manufacturing plants.

Accessible by three State highways, the City is also served by the Missouri-Kansas and Texas Railroad. Bastrop is expected to grow slightly due to its proximity to Austin and the proximity of nearby vacations, weekend, and retirement homesites.

The municipal water supply is obtained solely from a ground water source. The water is drawn from five wells and stored in one elevated reservoir with 0.50 mg capacity and in two ground reservoirs with capacities of 1.0 mg and 0.22 mg. Three of the wells have pumping capacities of 650 gpm each, one has a capacity of 550 gpm and the other has a capacity of 600 gpm.

The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.47	0.53	0.60	0.79
Industrial Use	0.006	0.006	0.008	0.01

*Flows in mgd

In addition to these estimates of water use, which are based on theoretical per capita use rates, should be added to the water the City sells to the Aqua Water Supply Corporation and to areas outside the present city limits such as Bastrop State Park. Reportedly, these additional flows result in a present average use of approximately 1.0 mgd.

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.31	0.34	0.39	0.52
BOD in lb/day	529	625	707	990
TSS in lb/day	622	729	865	1,198

The estimated flows do not include the effect of any expansions of the collection system to incorporate developing areas outside the existing city limits.

The only known significant industrial discharge into the system is from a local slaughterhouse which occasionally places heavy loads on the plant. The discharge from this source is expected to continue.

The existing wastewater collection system is illustrated on Plate CA-1. The system is located throughout the City and is comprised primarily of 6- and 8-inch clay pipe with 10- and 12-inch clay pipe in the main trunk. Due to the lack of adequate relief or extensive drainage system, the frequent heavy rains associated with the Gulf area cause water to pond in several areas of the city. Coupled with this ponding is the phenomenon associated with sewer line excavation in clay-type soils. Once the trench soils have been disturbed, an interface is continually present between the disturbed and the undisturbed soils as the clays expand and contract with the available moisture. When ponding occurs above lines laid in these clays, as it does in Bastrop, the system suffers badly from the high rate of infiltration. In almost all instances of this type of infiltration, it is more practical to relieve the drainage problem, which in turn reduces infiltration, than it is to attempt to stop infiltration by other means. Also characteristic of lines laid in clay soils is the heaving and buckling associated with the moisture conditions. This continual movement cracks pipes, separates joints, and would certainly destroy any remedial patchwork such as in-line groutings.

The southeastern part of the City and other outlying, scattered areas still utilize septic tanks as the primary means of sewage disposal. Since the units are widely separated and causing no known difficulties, the City has no plans for abandoning this mode of disposal in these areas.

It has been proposed in earlier reports to construct the relief sewer through the center of town as shown on Plate CA-1. It is estimated that this sewer would have a total project cost of $186,300, including engineering and contingencies. It is recommended that the City improve its drainage problem prior to initiating construction as described previously and revise the original analysis accordingly.

The system extensions shown for the north side of town are proposed to serve the projected population growth for the City. The estimated total project cost for these extensions is $107,700, including engineering and contingencies.

The existing sewage treatment plant for Bastrop is located on the southwestern edge of the City, as shown on Plate CA-1. The plant, constructed in 1951, with a design capacity of 0.245 mgd, presently serves about 2,940 people. The plant is of the activated sludge type and consists of a primary clarifier, two aerators, a final clarifier, and a chlorination unit. Available sampling data published by the Texas State Department of Health and the TWQB is as follows:

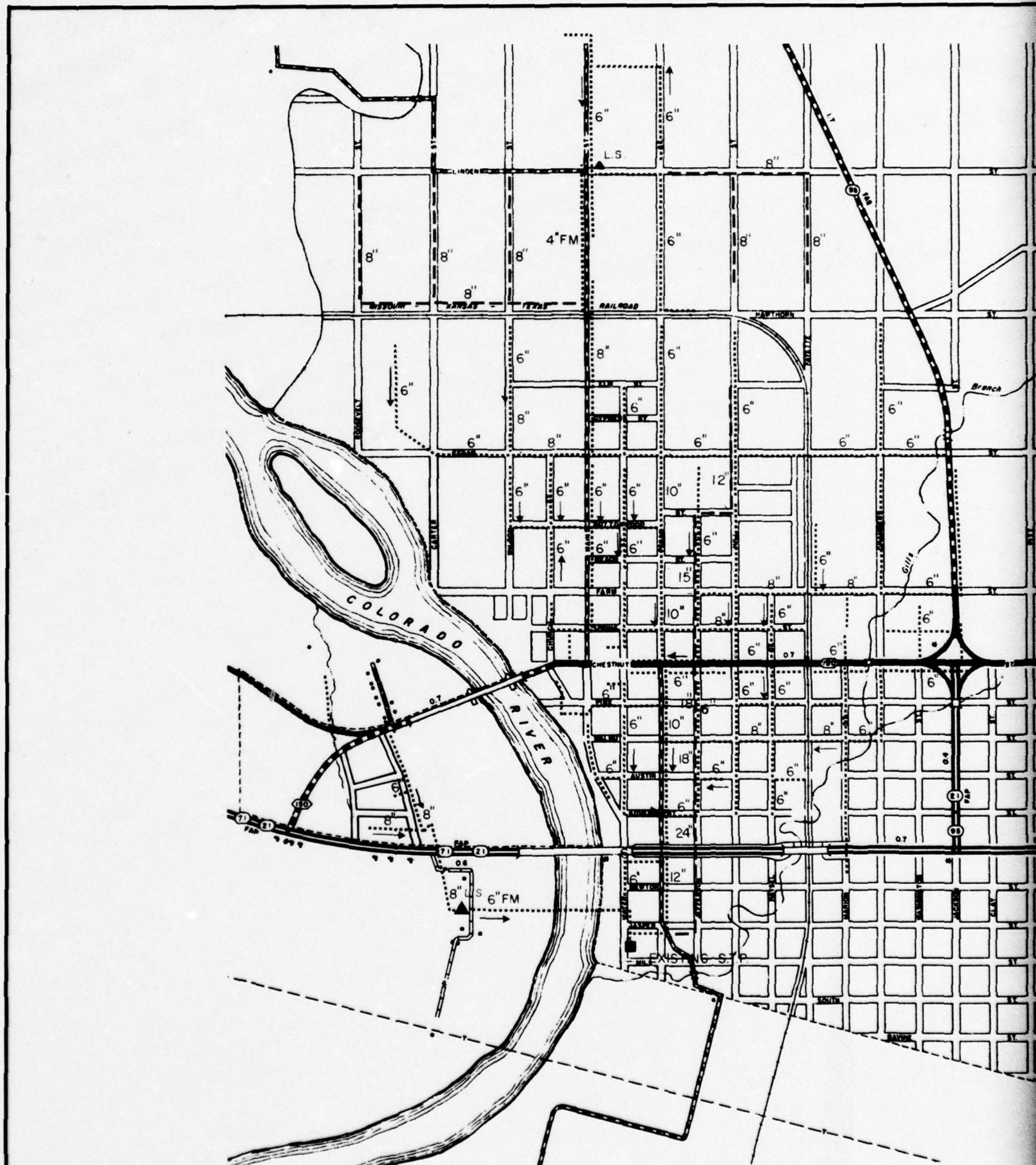
Influent-Efluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)		430
Raw TSS (ppm)		999
Final BOD (ppm)	30	60
Final TSS (ppm)	35	73

Sludge disposal consists of utilizing the material as land fill or as a soil conditioner. Effluent from the chlorination unit is discharged into the Colorado River. Mathematical modeling accomplished for this study has indicated that the discharge from Bastrop through the planning period at the present level of permitted constituents would not result in any violation of stream standards in the Colorado River.

The present facility is operating at or above its design volumetric capacity. In addition, the occasional release of heavy loads from the local slaughterhouse exceeds the plant's biological capacity with a corresponding increase in discharge constituent levels. The plant is of a design which is known to have constant maintenance and operational difficulties, and it has been proposed in earlier reports that a new plant be constructed of a modern, efficient design. This study concurs with that basic recommendation, and it is proposed that the new facility be of the activated sludge type operated in the contact-stabilization mode constructed to a capacity of 0.5 mgd. It is also recommended that as much of the present facility as can be salvaged be incorporated into the design as stormwater clarification facilities, chlorine contact chambers, or surge basins. The estimated total project cost for construction by 1977 of this secondary facility is $358,500, including engineering and contingencies but exclusive of any salvageable items.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977, and the best



L.S
4"FM
COLORADO
RIVER
CHESTNUT
AUSTIN
LINDEN
RAILROAD
Branch
Gills
8" L.S 6"FM
EXISTING S.T.P.

NOTE: EXHIBIT DOES NOT SHOW SPECIAL 6" LATERALS ON TRUNK SEWERS

LEGEND

.... EXISTING SEWER LINES

— — — PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BASTROP, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE 1" = 1500' | PLATE CA-1

2

practicable waste treatment technology by 1983. According to the present interpretation of this law, an activated sludge plant as proposed will meet all secondary treatment requirements of the law until 1983. At that time the City will need to provide a higher level of treatment than a secondary facility could produce. Land disposal of effluent by irrigation meets all requirements of the law when the disposal is executed in an approved manner, and when no effluent is introduced into the surface water or ground water resource as direct runoff or by percolation without adequate treatment time.

Should the City choose to utilize irrigation as the means of final effluent disposal, they may either contract with local farmers who would store and utilize the water or may own and operate their own facilities. Capital cost for the latter alternative, to meet 1983 requirements, is estimated to be $239,700. This cost includes holding pond, irrigation equipment, land, and engineering and contingencies. Economies could be gained by entering into agreement with local farmers or by creating an impoundment from a dry draw. Data furnished by the General Land Office indicates there are areas south of the City that are currently being irrigated. An agreement with these local farmers would provide for a valuable reuse of the Basin's water resource and should be given primary consideration.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plant be undertaken. However, should the City of Bastrop wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $358,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $190,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $168,000, including engineering and contingencies.

<u>Elgin, Texas.</u>

The City of Elgin is an incorporated general law municipality located in the northern portion of Bastrop County at the intersection of U.S. 290 and S.H. 95 approximately 20 miles east of Austin, Texas. The incorporated area of the City encompasses approximately 1,320 acres and lies within the jurisdiction of the CAPCO.

The City has moderate topographical relief and is drained by two creeks. Elm Creek, flowing to the northwest, drains the northern portion of the City while Little Sandy Creek, flowing south, drains the central and southern portions of Elgin.

The City is primarily underlain by soils of the Crockett and Wilson types. The Crockett soil has a friable, acid, sandy loam to clay loam surface, generally 7 to 12 inches thick, over very firm and very plastic, blocky, acid clay. The surface soil is very tight and crusty when dry. The Wilson soil has an acid, sandy loam to clay loam surface, 4 to 12 inches thick, over a very firm, blocky to massive, neutral clay. Surface soil is also very tight and hard when dry. Permeabilities are less than 0.06 inch per hour causing sever limitations for septic tanks. The impermeable soils impose only slight limitations on sewage lagoons with slopes greater than two percent.

Population data developed by the TWDB for use in this study indicate that a moderate increase in population is anticipated for Elgin over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	3,832	4,360	4,940	6,650

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and concentrated commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no known significant industrial contribution.

Accessible by a U.S. highway and a State highway, the City is served by the Southern Pacific Railroad and the Missouri-Kansas-Texas Railroad. Anticipated growth potential is good due to the close proximity of Austin, Texas, and the recent interest in the area for vacation, weekend, or retirement homes. The nearby State park will generate minor growth from tourist-related services. However, the primary growth potential will come from new permanent and semi-permanent home owners whose need for construction and services will stimulate the economy.

The municipal water supply is obtained solely from ground water sources. The water is drawn from three wells with pumping capacity of 350 gpm each and stored in two ground reservoirs with capacities of 0.088 mg and 0.4 mg. The projected water use, a reflection of the population trend, has been anticipated by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.47	0.66	0.75	1.0
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.38	0.44	0.49	0.66
BOD in lb/day	651	785	889	1,264
TSS in lb/day	766	916	1,087	1,530

Due to the lack of flow records from the plant, all assumptions regarding the present loading in this study and prior reports have been theoretical calculations on a flow per capita basis. The waste load projections accomplished by the TWQB for this study were based on 100 gallons per capita per day (gpcpd) from a 100 percent contributing population. Field inspections and experience with other cities of comparable size have revealed that not 100 percent of the population is contributory and that the per capita is flow rate is probably not as high as 100 gpcpd. Thus, although waste load projections indicate that the plant is not at or above its design capacity, in actuality, the dry weather influent load is probably somewhat below the stated design capacity.

There are no known significant industrial discharges into the municipal collection system. Approximately one mile south of the city limits is located a meat processing operation that is permitted to dispose of all liquid wastes by irrigation. It does not appear feasible or reasonable to attempt to incorporate this waste into the municipal system since the present method of disposal is satisfactory.

The existing wastewater collection system is shown on Plate CA-2. The system is comprised of 6- to 8-inch clay pipe with some 12-inch clay pipe in the outfall line. Several lift stations are utilized in the system due to the hilly terrain of the area. The system is basically in good condition although some minor infiltration occurs in the older lines. There are no significant areas of town where septic tanks are the primary means of sewage disposal. The proposed lines shown on Plate

CA-2 are planned to serve the anticipated population growth. In addition, it has been stated in earlier reports that with the additional flow contribution, particularly from the northeast sector, relief will have to be provided for the main trunk line through the center of the City. This relief line is also shown on Plate CA-2. The total estimated project costs for these system improvements including lines, pump stations, engineering and contingencies are as follows:

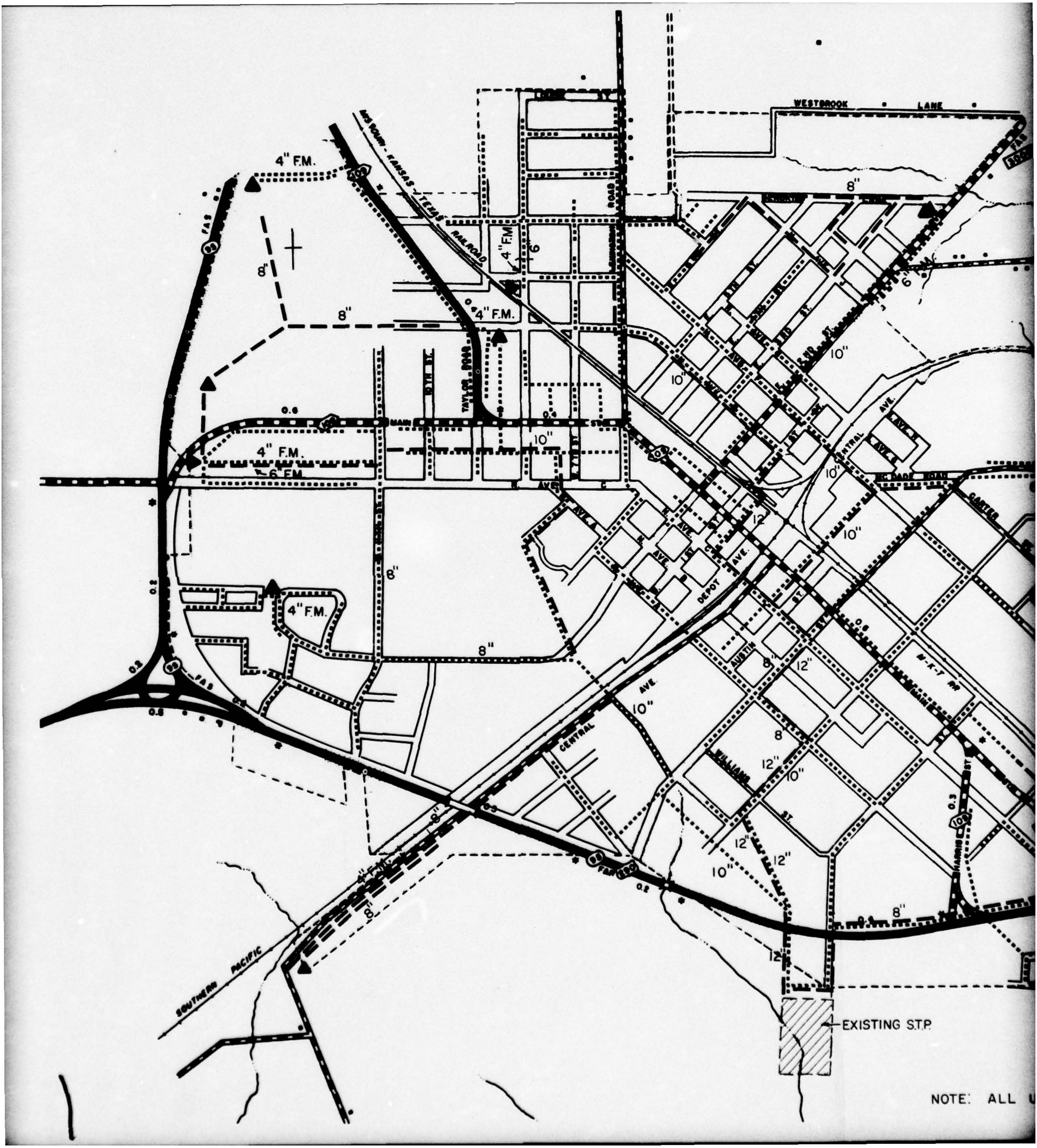
Area of Improvement	Estimated Cost
Northeast Area	$123,500
Southeast Area	86,000
Southwest Area	70,500
Northwest Area	127,500
Relief Trunk Sewer	152,000

The existing sewage treatment plant for Elgin is located southwest of the City as shown on Plate CA-2. Constructed in 1962, with a design capacity of 0.375 mgd, the plant presently serves about 3,500 people with some 1,050 sewer connections. The plant is in good condition and is well maintained. It is of the trickling-filter type and consists of a bar screen and grit chamber, two pre-aerators, a primary clarifier, a trickling filter, a two-stage digestor, two sludge drying beds, and five oxidation ponds in series. Available sampling data published by the Texas State Department of Health and the TWQB are as follows:

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	170	165
Raw TSS (ppm)	120	116
Final BOD (ppm)	75	75
Final TSS (ppm)	125	125

Sludge disposal consists of spreading the material on the plant site or on City property. Effluent from the final oxidation pond is discharged into Little Sandy Creek which is tributary to Big Sandy Creek and the Colorado River. The excessively high BOD_5 and TSS measurements are believed to be a result of algae carry-over from the oxidation ponds. This condition of high BOD and TSS is characteristic of discharges from oxidation ponds



WESTBROOK LANE
MISSOURI - KANSAS - TEXAS RAILROAD
4" F.M.
8"
6"
10"
12"
6" F.M.
TAYLOR ROAD
MAIN ST.
AVE. C
CENTRAL AVE.
DEPOT AVE.
AUSTIN AVE.
WILLIAMS ST.
HARRIS ST.
M-K-T RR
SOUTHERN PACIFIC
MC DADE ROAD
CARTER
EXISTING S.T.P.
NOTE: ALL

LEGEND

- .... EXISTING SEWER LINES
- — — — PROPOSED SEWER LINES
- ▲ LIFT STATION

NOTE: ALL UNLABELED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS
ELGIN, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'   PLATE CA-2

which have been placed after a secondary process to "polish" the effluent. The algae cell matter exerts an oxidation demand as it contributes to the solids measurement. In addition, nutrients discharged by the secondary facility are taken up by the algae during photosynthesis and are, thus, present in the final discharge to virtually the same concentrations.

Under the requirement of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best waste treatment technology by 1983. It is the current interpretation of this law that the constituent levels which will be utilized to define secondary treatment will not be attainable solely by a trickling filter process, and the City will be faced with providing a higher degree of treatment if it is to continue to discharge. As an alternative to costly tertiary waste treatment facilities that a city the size of Elgin would have difficulty supporting, it is proposed the City dispose of all effluent through irrigation. Also within the present interpretation of the law, land disposal of effluent meets all treatment requirements for 1977 and through 1985 when the disposal is executed in an approved manner and when no effluent is introduced into surface water or ground water resources either by direct runoff or by percolation without adequate treatment time.

Should the City choose to dispose of all effluent by irrigation, two insititutional alternatives are available. The City may either contract with a local farmer who would take all effluent and provide all irrigation facilities or the City may own and operate the system. The latter alternative for implementation by 1977 is estimated to cost $244,600, which would include a 15-acre 60-day holding pond, irrigation equipment, 67 acres of land and engineering and contingencies. If arrangements can be made with local farmers to either take the water or allow the City to use their land, some substantial costs such as land acquisition can be greatly reduced. In addition, some economies can be affected by choice of the impoundment location; a small dry draw could be made into a reservoir for substantially less than the estimated cost.

As stated previously, a discrepancy exists regarding the actual loading on the present facilities. Unfortunately, the discrepancy cannot be rectified until accurate flow measurement is obtained; however, it is the judgment of this report that the present facilities will have adequate capacity until about the year 1990. At that time the City should consider adding sufficient secondary and irrigation capacity to bring its total capacity to approximately 0.6 mgd which will be adequate through the year 2020. Whether or not the present facilities can be incorporated into the 1990 plant expansion will have to be determined at that time; however, since the plant would be 30 years old, it is anticipated the new facilities would be sized to replace the present units. The total project cost for the 0.6 mgd secondary unit is estimated to be $417,200 including engineering and contingencies, and the expansion cost for the irrigation facilities is estimated to be $56,100 including engineering and contingencies, and 26 acres of land at $1,000 per acre.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Elgin wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $281,700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $156,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $143,000, including engineering and contingencies.

Smithville, Texas.

The City of Smithville is an incorporated general law municipality located in the southeast portion of Bastrop County on S.H. 71 immediately south of the Colorado River and approximately 45 miles southeast of Austin, Texas. The incorporated area of the City encompasses approximately 1,560 acres and is located within the jurisdiction of the CAPCO.

The City, drained by the Colorado River and by Willow Creek, has little topographic relief. The northern half of the City drains into the Colorado River while the southern half drains into Willow Creek.

The City is underlain by soils of the Asa-Bastrop-Lewisville and Norwood-Yahola types. The Norwood-Yahola soils are reddish brown, calcareous loams, 9 to 25 inches thick, over light reddish brown, friable, silt loams. The Asa-Bastrop-Lewisville soils are well drained, friable, clay loams. Permeabilities range from 0.63 to 2.0 inches per hour. Septic tanks have only slight limitations and sewage lagoons have moderate limitations due to the high permeability.

Population data developed by the TWDB for use in this study indicate a moderate increase in population expected for Smithville over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,959	3,490	4,010	5,570

The land use for the City, generally typical of that of other small cities, is characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City and along S.H. 71. The economic resource base is primarily agricultural with some contribution from local oilfield activity and some light industrial contribution.

The City is accessible by S.H. 71, S.H. 95 and F.M. 2571. It is served by the Missouri-Kansas-Texas Railroad. Anticipated growth potential is good due to continued growth in agriculture, mineral production, light manufacturing, and tourism. Of the major significance to the local economy is the spirited interest in the surrounding land near the River for vacation, weekend and retirement homes for urban residents of both the Austin and Houston areas. This interest will stimulate the entire economy through construction and all service-related industries.

The municipal water supply is obtained from ground water by three wells with pumping capacities of 350, 500, and 500 gpm. Storage for the system is provided by 0.6 mg and 0.05 mg ground storage tanks and a 0.15 mg elevated tank. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.32	0.42	0.50	0.77
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.30	0.35	0.40	0.55
BOD in lb/day	503	628	722	1,058
TSS in lb/day	592	733	822	1,281

There are no known industrial discharges in the Smithville vicinity that could be considered for incorporation into the municipal system. All light commercial and industrial discharges into the municipal system are insignificant and without threat to facilities.

The existing wastewater collection system, shown on Plate CA-3, is adequate to serve the present population with only minor extensions along the south edge of the City. No costs are included herein for these minor extensions. Expansions of the system to serve the projected population are also shown on Plate CA-3. The areas of growth are the area west of Gazley Creek and south of the railroad, and an anticipated development area south of the River and north of the railroad. The total estimated project costs for these major expansions, including engineering and contingencies, are $66,500, and $70,100 respectively. In addition, it has been determined in earlier reports that the incorporation of a substantial area east of the City into the system will necessitate a relief sewer through the center of town. This line, as proposed, is also shown on Plate CA-3. Total estimated project cost for the relief sewer is estimated to be $94,000, including engineering and contingencies.

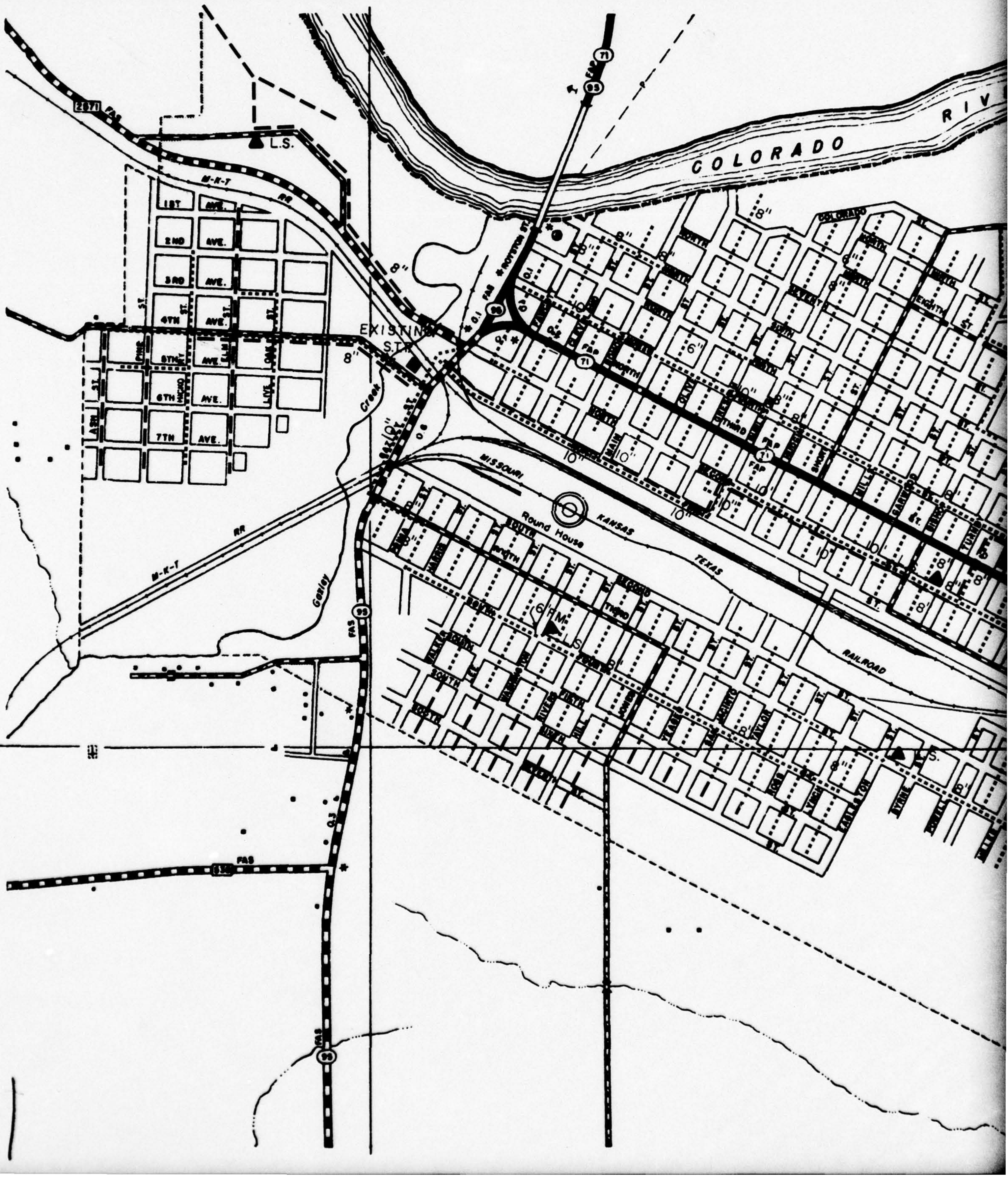
The existing sewage treatment plant for the City of Smithville is located on the west side of the City near Gazley Creek, as shown on the Plate. The plant was built in 1951 with a design capacity of 0.265 mgd and presently serves about 2,800 people. The plant is of the trickling-filter type and consists of a primary clarifier, two-stage trickling filters, a final clarifier, and anaerobic digestor, sludge drying beds and a flow meter. Available sampling data published by the Texas State Department of Health and by the TWQB are as follows:

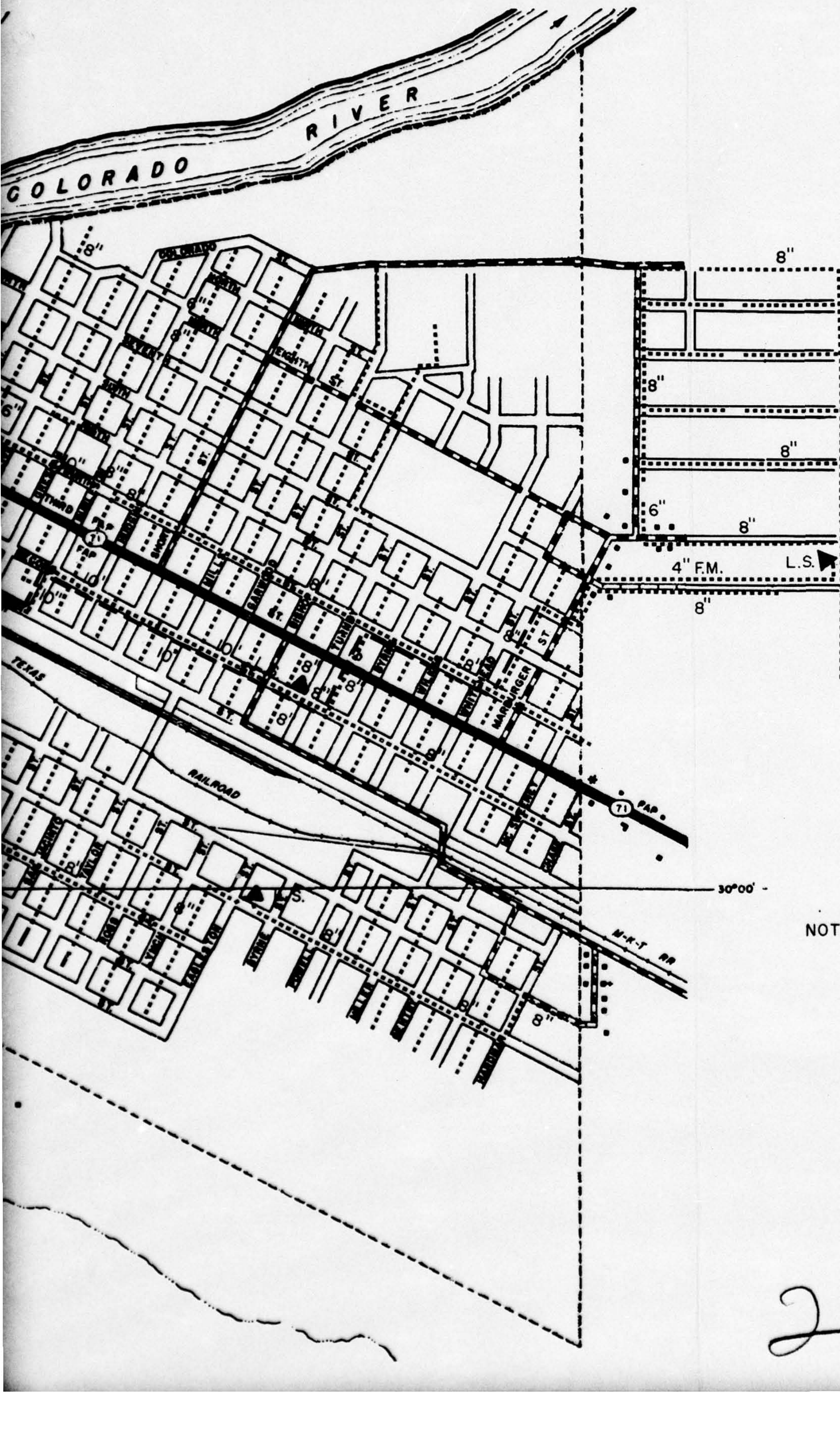
Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	190	190
Raw TSS (ppm)	110	112
Final BOD (ppm)	50	50
Final TSS (ppm)	47	47

The plant is presently at or exceeding its stated design capacity and is consistently in violation of its waste discharge permit. Effluent from the plant is discharged into Gazley Creek several hundred feet above its confluence with the Colorado River. Sludge from the plant is utilized as fertilizer on nearby cropland.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of this law that the constituent levels which will be utilized to define secondary treatment will not be attainable solely by the trickling filter process. It is also doubtful that by the nature and proven efficiency of trickling filters the City could ever be in compliance with the constituent levels established on its discharge permit. The City currently has under


COLORADO RIV
L.S.
M-K-T RR
1ST AVE.
2ND AVE.
3RD AVE.
4TH AVE.
5TH AVE.
6TH AVE.
7TH AVE.
EXISTING S.T.P.
Creek
Gosley
FAS
MISSOURI
KANSAS
TEXAS
RAILROAD
Round House
COLORADO
8"
10"
6"
8'
10'



LEGEND

··········	EXISTING SEWER LINES
— — —	PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SMITHVILLE, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE CA-3

2

consideration an activated sludge facility to be operated in the extended aeration mode in a variation commonly referred to as a race track oxidation ditch. This study is in general concurrence with the above recommendation to abandon the trickling filter plant land install a facility of the activated-sludge type. However, from the nature and economics of the activated sludge process, the efficient range of the extended aeration mode is far below the capacity that would be required for Smithville. It is recommended that the City consider construction of a type of activated sludge plant that can be operated in the contact-stabilization mode and easily converted to conventional activated sludge when the influent load increases with the population to a point where the greater efficiency is obtained by conventional activated sludge. A race-track-oxidation-ditch type facility would not allow this flexibility. The estimated total project cost for an activated sludge unit of 0.5 mgd capacity would be $358,500, including engineering and contingencies.

In order to be in full compliance with this law, by 1983 the City must achieve the best practicable waste treatment technology. It is therefore recommended that the City enter into agreement with local farmers who would utilize the effluent for irrigation or cropland.

Under the present interpretation of the law, land disposal of effluent through irrigation meets all requirements when the disposal is carried out in an approved manner and when no effluent is introduced into the surface water or ground water resource either directly as runoff or by direct percolation.

The alternative to agreement with local farmers would be for the City to maintain and operate the irrigation farm. The total capital cost for implementation by 1983 is estimated to be $253,000, which includes construction of an 18-acre holding pond, pumps and force main irrigation equipment and 51 acres of land.

Effluent irrigation in the Colorado River Basin has proven to be an acceptable and economical method of obtaining a high level of waste treatment while providing maximum reuse of a valuable natural resource and eliminating contamination of the Colorado River.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Smithville wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $358,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $190,000, including engineering land contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $168,000, including engineering and contingencies.

Johnson City, Texas.

Johnson City is an incorporated general law municipality located in the central portion of Blanco County at the intersection of U.S. 281 and U.S. 290, approximately 50 miles west of Austin, Texas. The incorporated area of the City encompasses approximately 300 acres. Johnson City is the county seat of Blanco County and is a member of the CAPCO.

The City has moderate topographical relief and is drained by Town Creek and by one of its branches. The City drains to the north-northeast toward the Pedernales River; Town Creek runs from the west to the northeast along the edge of town while its branch runs along the east boundary of the City to the north. Elevations vary 80 feet from the south to the north. The City is underlain by soils of the Brackett-Tarrant Stony type. The Brackett-Tarrant Stony soils, generally 4 to 8 inches thick, are characteristically calcareous clay loams containing numerous large fragments of limestone. Broken or partly weathered limestone bedrock appears at less than 12 inches below the surface. Permeabilities range from 0.2 to 0.63 inch per hour; however, septic tanks have severe limitations due to the depth of the bedrock. The Pedernales soil type which borders the town to the northwest is generally 10 to 15 inches thick and generally has a clay loam surface over a sandy clay. Permeabilities range from 0.63 to 2.0 inches per hour. Septic tanks have severe limitations due to the shallow bedrock, and sewage lagoons range from slight to severe limitations due to the high permeabilities.

Population data developed by the TWDB for use in this study indicates a slight increase in population expected for Johnson City over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	767	830	900	1,030

Typical of other small cities, land use for the City is characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic-resource base is primarily agricultural with no known industrial contribution.

The City is accessible by U.S. 290 and U.S. 281 and F.M. 2766 and is served by Waller Airfield and Winter Airfield. Anticipated growth potential is slight due to a lack of any significant natural resource. The

existence of several historical sights may aid the local economy during the tourist season, but the effect is not expected to stimulate any excessive population growth.

The municipal water supply is obtained from ground water and surface water sources. Storage for the system is provided by a 0.15 mg ground storage tank and a 0.10 mg elevated storage tank. Two 100 gpm wells serve the City in addition to water drawn from the Pedernales River by two pumps operating at 200 gpm each. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.11	0.13	0.16	0.21
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewate return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.08	0.08	0.09	0.10
BOD in lb/day	130	149	162	196
TSS in lb/day	153	174	198	237

The only light industrial contribution to the system is the discharge from a small locker plant. No known problems exist from the inclusion of this waste in the municipal system.

The existing wastewater collection system is shown on Plate CA-4. The system is apparently adequate for present needs and with only minor extensions, expansions, and a relief outfall line as shown, will meet the needs of the projected population. The total project cost for the relief sewer including engineering and contingencies is estimated to be $44,500. There are a few residences in the City which are presently served by septic tanks; however, no plans exist on the part of the residents or of the City to bring these homes into the system.

The municipal water treatment plant is located approximately 400 feet east of U.S. 281 northeast of the City near the wastewater treatment plant. Sludges from the sedimentation basin and filter backwash are dried on two sludge drying beds and eventually removed to a land fill site.

The existing wastewater treatment facility is located on a draw in a pasture northeast of the City. The plant consists of an Imhoff tank, sludge pits, and a series of oxidation ponds. The plant is old, in generally poor physical condition, and is in need of substantial overhaul and maintenance. The weirs of the Imhoff tank have never been level and as such allow short circuiting to occur. The first two small oxidation ponds are shallow and, therefore, have become completely choked with plant growth except for a small channel where the wastewater short-circuits the ponds. The average depth of the final two ponds is estimated to be less than two feet. Available sampling data published by the Texas State Department of Health and the TWQB are as follows:

Influent and Effluent Data

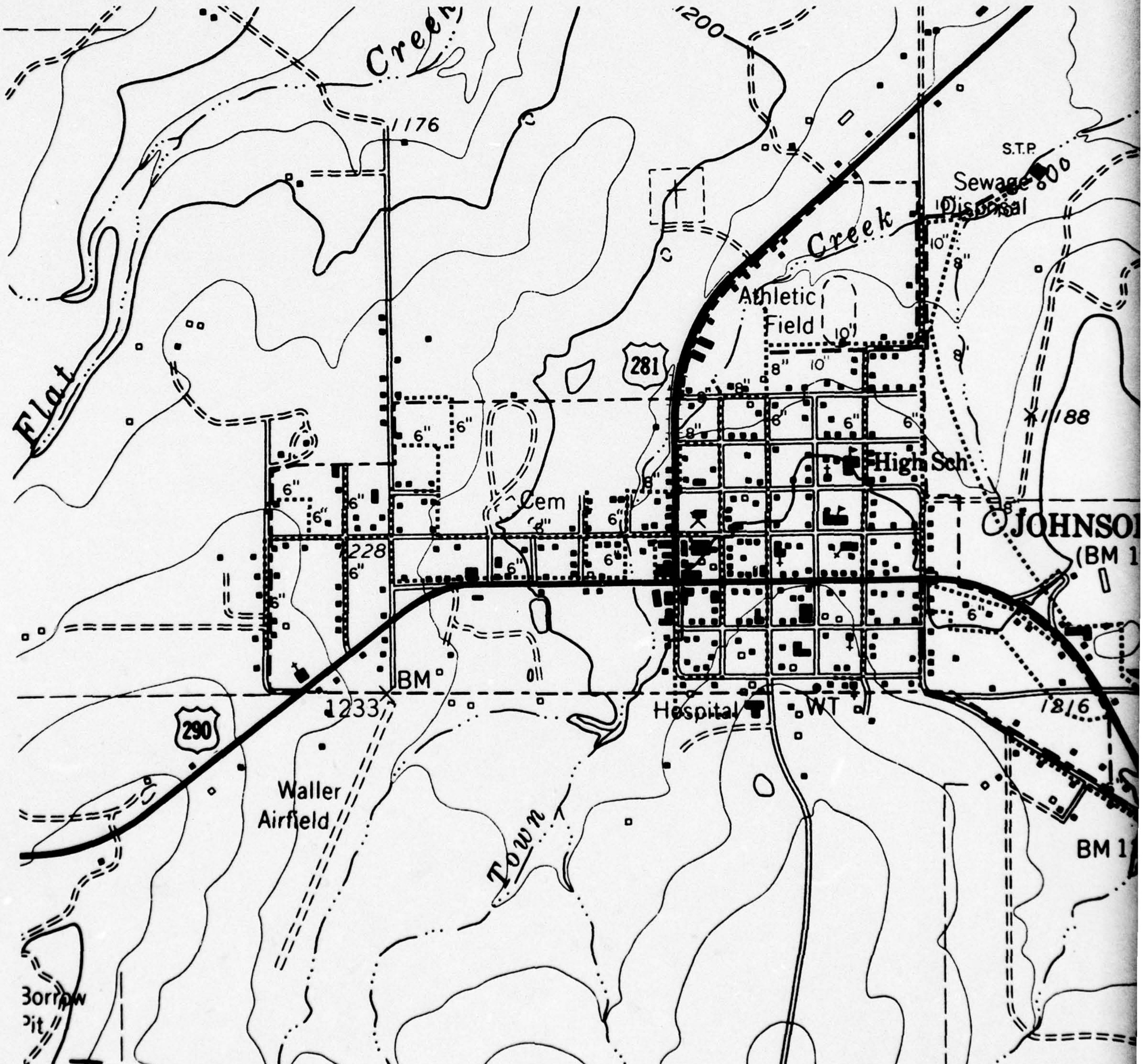
	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	120	45
Raw TSS (ppm)	130	39
Final BOD (ppm)	6	17
Final TSS (ppm)	10	15

Waste from the ponds is either used by the local farmer to irrigate or is allowed to spread across the bottom of the draw and eventually into the Pedernales River. Sludges are to be used as fill material.

The plant was built in 1952 with a stated design capacity of 0.126 mgd and presently serves approximately 700 people. What little influent and effluent data that is available from the Texas State Department of Health and TWQB does not appear representative of what the system is likely to discharge.

The present method of treatment which utilizes irrigation of the effluent should provide a high degree of treatment that is beneficial to the local economy with a minimum effect on the environment. Two significant needs should be considered by local officials at the earliest possible date: extensive overhaul of the existing plant and formulation of contractual agreements with the local irrigator.

The Imhoff tank should be cleaned out, and, in the process, the weirs should be leveled and any necesary valving replaced. Although the



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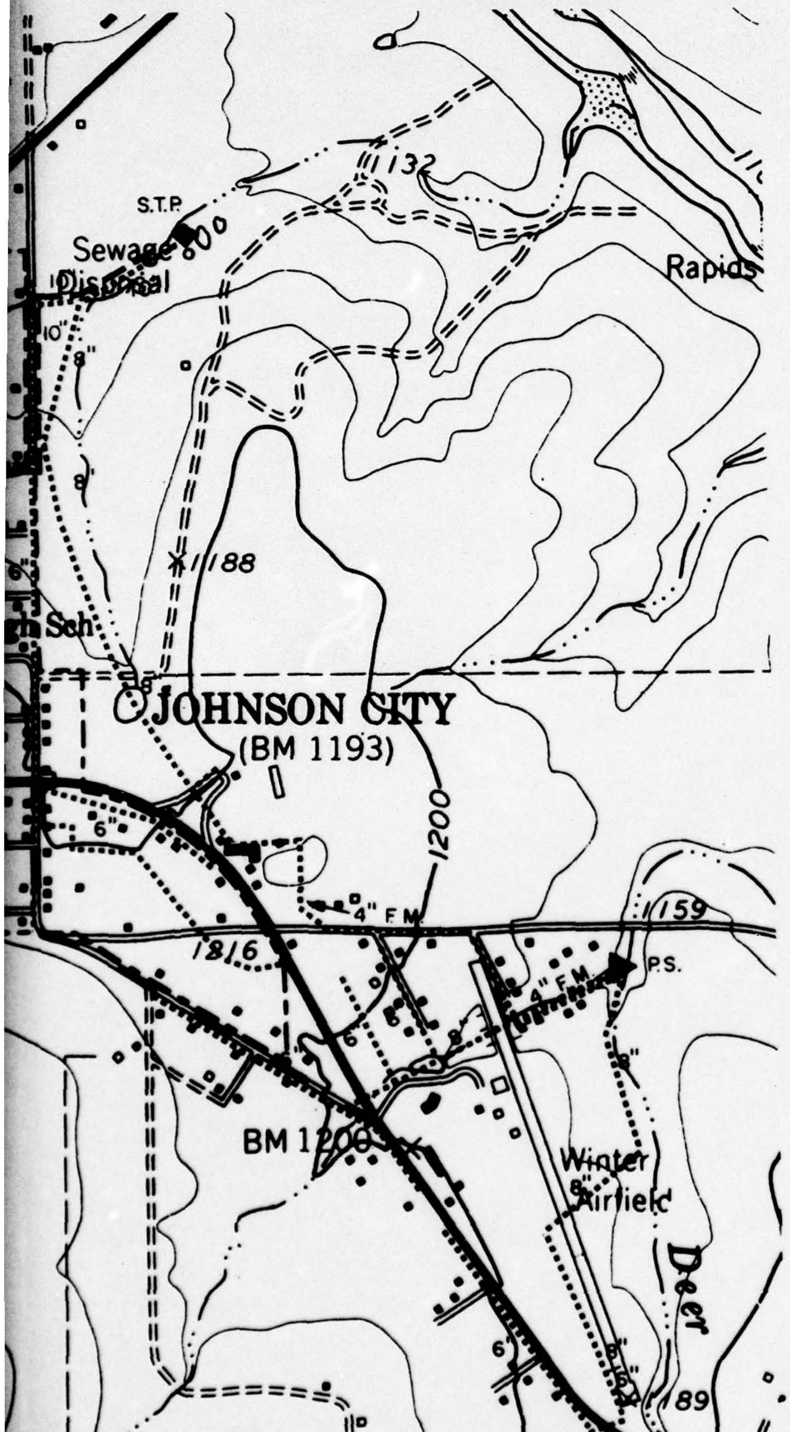


LEGEND

.... EXISTING SEWER LINES

— — — PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS
JOHNSON CITY, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1000' — PLATE CA-4

Imhoff tank is fenced to prevent animal entry, the oxidation ponds were not and cattle graze and wade freely. The area should be fenced to comply with Health Department regulations. The oxidation ponds should be drained, empted of accumulated sediments and plant growth, and their combined surface area should be increased to approximately 4.0 acres. The cost for this excavation is estimated to be $39,900 including engineering and contingencies. In addition, it is recommended the City replace the sludge pits with two small sludge drying beds at an estimated total project cost of $2,400 including engineering and contingencies.

The irrigation agreement should be formalized to insure that irrigation is practiced throughout the year and no discharge is allowed to escape to the Pedernales River via Town Creek. Excavation of the oxidation ponds will provide additional storage and will allow the irrigation system more flexibility.

It is therefore recommended that all steps necessary to comply with the aforementioned no-discharge plan be undertaken. However, should the City of Johnson City wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $139,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $102,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $99,000, including engineering and contingencies.

Burnet, Texas.

The City of Burnet, an incorporated general law municipality, is located in the central portion of Burnet County at the intersection of U.S. 281 and S.H. 29 approximately 45 miles northwest of Austin, Texas. The incorporated area encompasses approximately 900 acres. Burnet, the county seat of Burnet County, lies within the jurisdiction of the CAPCO.

Burnet, situated in a valley, slopes approximately 60 feet from the northwest to the south. The City is entirely underlain by Tarrant-Crawford soils. These soils have a friable, high calcareous, clay surface, 4 to 8 inches thick, over broken or partly weathered lilmestone or limestone bedrock at less than 12 inches beneath the surface. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons both have severe limitations due to the shallow depth of the bedrock.

Population data, developed by the TWDB for use in this study, indicate that a moderate increase in population is expected for Burnet over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,864	3,200	3,620	4,890

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is primarily based on agriculture with some industrial contribution, specifically, stone processing plants. Accessible by a State highway and a U.S. highway, Burnet is served by the Southern Pacific Railroad and by an airport. Anticipated growth potential for the City is good due to its close proximity to Austin, Texas.

The municipal water supply consists entirely of ground water reserves drawn by three wells - two with capacities of 650 gpm and one with a capacity of 275 gpm. Storage is provided by two ground reservoirs with 0.350 mg and 0.100 mg capacities and two elevated storage tanks with a 0.400 mg capacity each. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	.43	.52	.60	.90
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.29	0.32	0.36	0.49
BOD in lb/day	487	576	652	929
TSS in lb/day	573	672	796	1,125

The existing wastewater collection system, shown on Plate CA-5, is adequate to serve the present population. Septic tanks are still the primary means of sewage disposal in scattered areas of town, primarily the southern sections of town. There are no known pollution problems at the present as a result of septic tanks. However, expansions of the collection system will be required to serve the projected population and those areas presently utilizing septic tanks. These expansions are also shown on Plate CA-5. Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O &M
1975	$162,200	$3,200
1980	129,000	2,600
1990	109,600	2,200

Burnet's existing sewage treatment plant is located 1/2 mile south of the city limits. The plant, constructed in 1966, with a design capacity of 0.475 mgd, presently serves about 2,500 people and one packing plant. It is maintained in good mechanical and structural condition. The plant is of the activated-sludge type and consists of a bar screen, a flow meter, a contact-stabilization unit, a clarifier, four oxidation ponds, and a chlorination chamber. Available sampling data, published by the TSDH and the TWQB, is as follows:

Influent and Effluent Data

	TSDH (1970)	TWQB (1970)
Raw BOD (ppm)	200	200
Raw TSS (ppm)	190	190
Final BOD (ppm)	5	5
Final TSS (ppm)	10	10

Sludge disposal consists of utilizing the dried material as fill and fertilizer. Effluent is used for irrigation adjacent to the plant site.

The industrial wastewater sources in the area are a meat packing plant, which discharges only a small flow to the plant, and the Texas Construction Materials Plant, which treats its own wastes. The wastewater from limestone washing, crushing, and screening is detained in two settling ponds, and the overflow is discharged into Hamilton Creek.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best available technology economically achievable by 1983. According to the present interpretation of this law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate renovation time.

From the population projections and projected wastewater return flows presented, the existing sewage treatment plant will be adequate until about the year 2017. For this reason, no proposed expansion to the treatment facilities will be proposed for Burnet in this report.

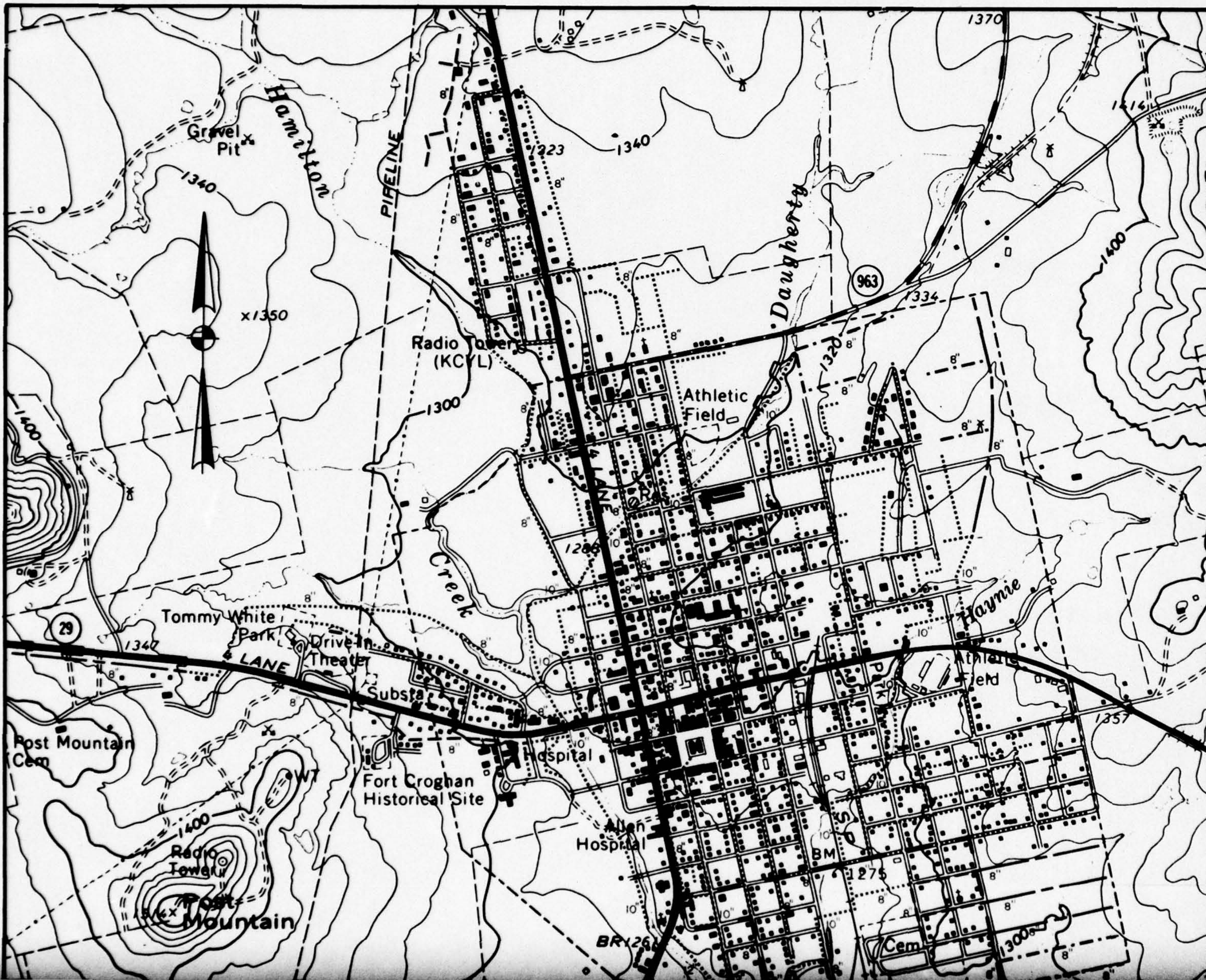
Land disposal of the secondary effluent is practiced on a 50-acre tract of pastureland adjacent to the treatment plant by the overland runoff method. The disposal field slopes from northeast to southwest at about a two percent grade. The renovated wastewater is collected in an irrigation drain ditch, which runs north-south along the west side of the spray field and transports the runoff to Hamilton Creek, located along the west edge of the tract.

Using an application rate of two inches per week for the overland runoff method of disposal (adopted as standard in this report), the size of the spray field required for the year 2020 population projection would be approximately 68 acres. Using a ratio of 50:68 times the projected population, the 50-acre tract is adequate to renovate the secondary effluent from a population of 3,603. From a plot of the population projections, this population is expected about the year 1990. Therefore by 1990 an additional 18 acres of land would need to be acquired to be adequate until year 2020. Additional application equipment and related facilities will also be required. The capital costs for expansion of the land disposal system by 1990, including an Aquatower sprinkler, effluent pump, distribution line, 18 acres of land and engineering and contingencies, are estimated to be $55,200.

It is therefore recommended that the aforementioned no-discharge plan be continued. However, should the City of Burnet wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $186,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $162,000, including engineering and contingencies.



Gravel Pit
Hamilton
PIPELINE
Daugherty
Radio Towers (KCYL)
Athletic Field
Creek
Tommy White Park
Drive-In Theater
Substa
Hospital
Fort Croghan Historical Site
Allen Hospital
Post Mountain Cem
Radio Tower
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Haynie
Athletic Field
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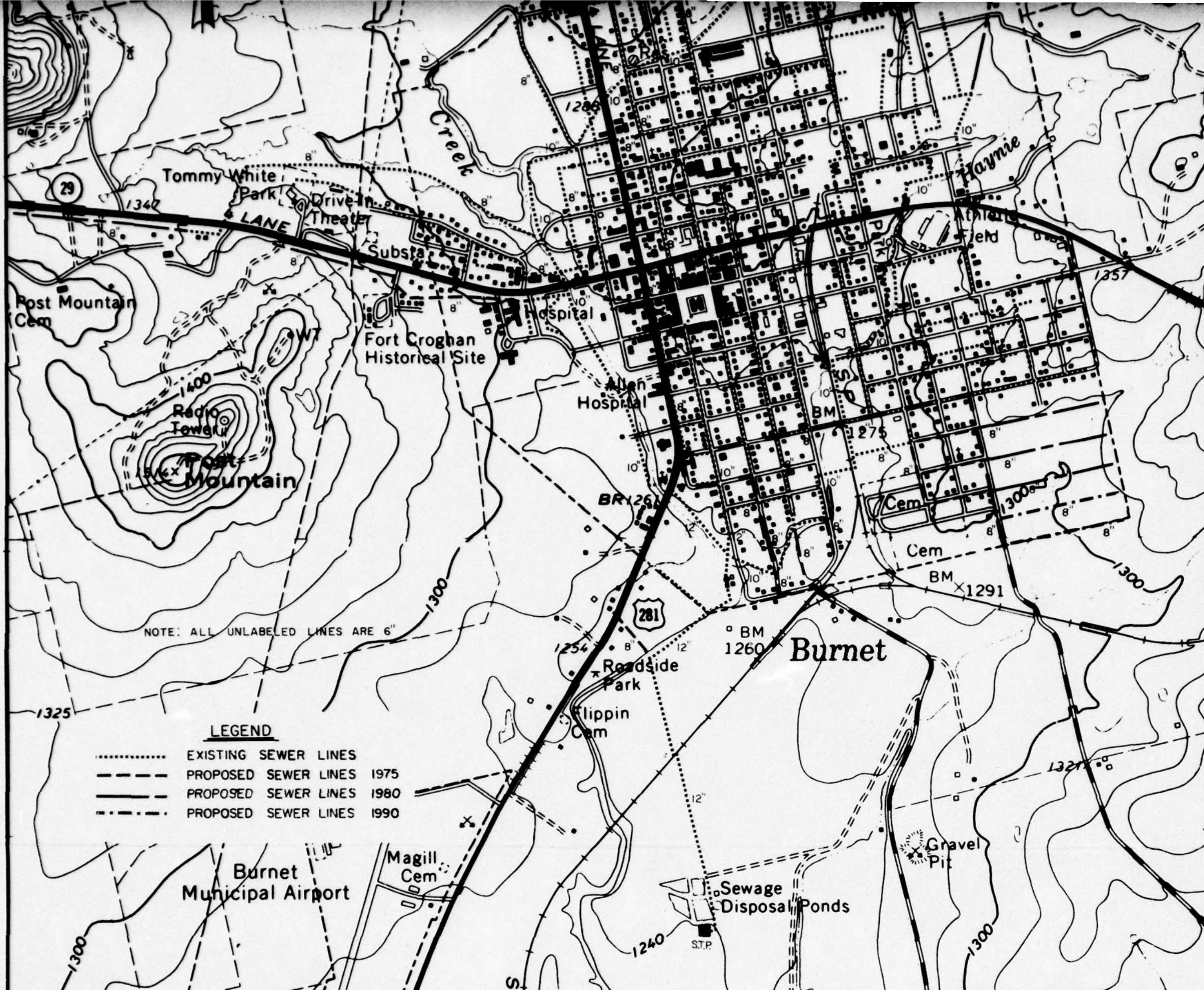


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BURNET, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON / PORT ARTHUR

SCALE: 1" = 1500' | PLATE CA-5

Carmine, Texas.

The City of Carmine is an unincorporated, general law municipality located in the northern portion of Fayette County on U.S. 290 and F.M. 458 approximately 70 miles east of Austin, Texas. The inhabited area of the City encompasses approximately 150 acres. The City lies within the jurisdiction of the CAPCO.

The City has little topographical relief and is drained by Cedar Creek and an unnamed tributary which flows into Cedar Creek below the populated area. The general direction of drainage is to the west with the north and south portions of the populated area draining to the centrally located Cedar Creek. The major portion of the inhabited area is underlain by soils of the Houston Black-Houston type. The Houston Black-Houston soils are generally very deep, well-drained, very slowly permeable, calcareous clay. When dry, cracks ranging in widths from 0.4 to 4 inches in width may appear at a depth of 20 inches. This soil is clayey throughout and very sticky and plastic. Permeability for Houston Black-Houston soils is less than 0.06 inch per hour. Septic tanks, therefore, have severe limitations due to the extremely slow permeability, and sewage lagoons would have slight to moderate limitations depending on the side slopes due to the cracking problems.

Population data developed by the TWDB for use in this study indicate a moderate decrease in population is expected for Carmine over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	510	410	340	160

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no known industrial contribution.

The City is accessible by U.S. 290 and F.M. 458 and is served by the Southern Pacific Railroad. Anticipated growth potential is slight due to a lack of adequate economic activity or resource availability. It is anticipated that the City will continue as a localized agricultural community throughout the planning period.

The municipal water supply is obtained from a ground water source. Storage for the system is provided by a 30,000 gallon ground tank and a 40,000 gallon pressure tank located at the one well which serves the City. No surface water supplies are utilized at the present time. The projected water use is a reflection of the population trend and has been projected to be as follows:

Water Use Projections*

	Year 1970	1980	1990	2020
Municipal Use	0.05	0.04	0.04	0.02

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

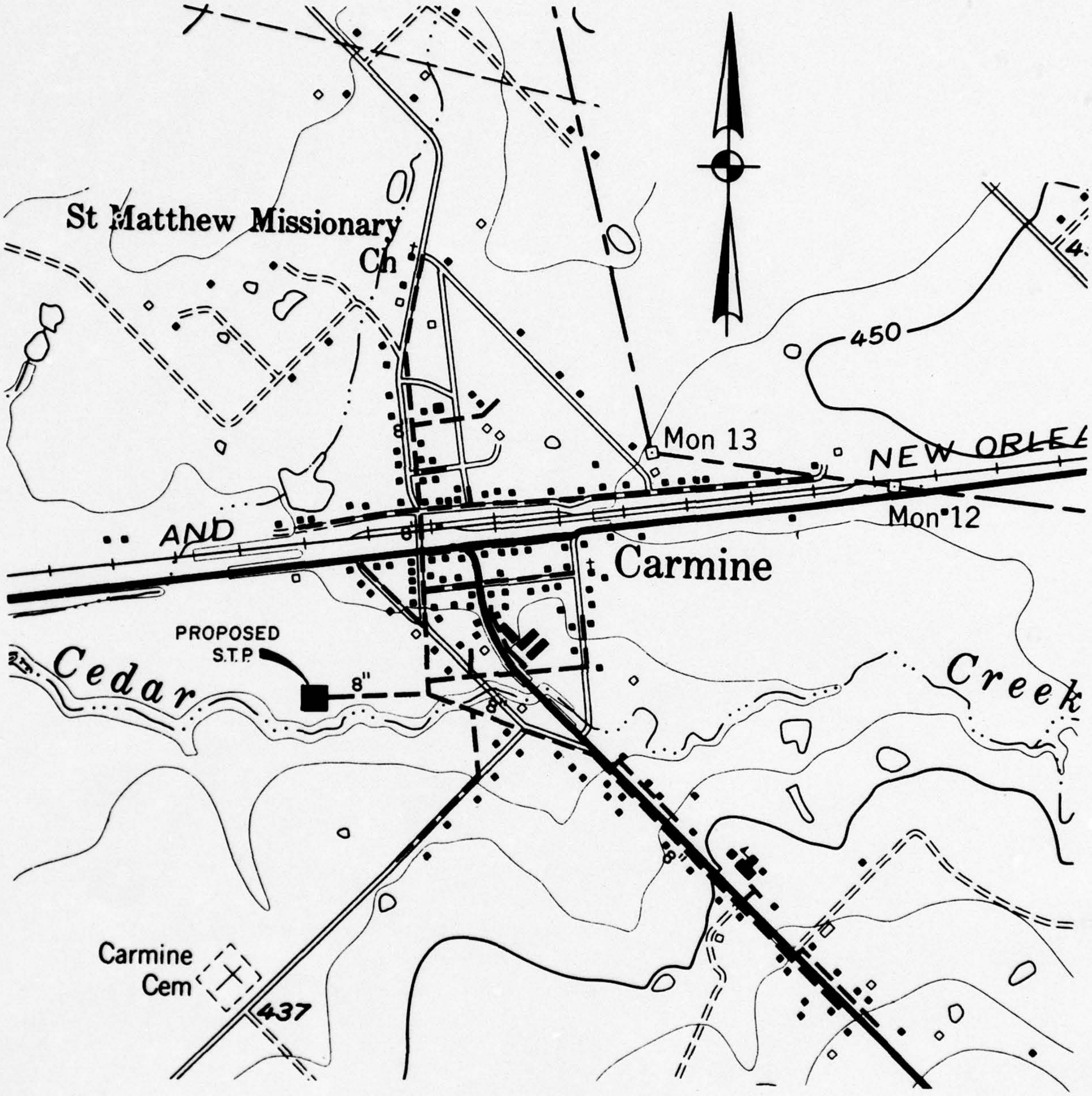
Waste Load Projections

	Year 1970	1980	1990	2020
Flow in mgd	0.05	0.04	0.03	0.02
BOD in lb/day	87	74	61	30
TSS in lb/day	102	86	75	37

At present, the entire City is served by septic tanks; however, a review of published soils information indicates that the soils place severe limitations upon septic tank drain fields. To alleviate any such problem, a collection system and a wastewater treatment system should be constructed by 1975. The capital cost for the proposed collection system, including 8,400 feet of six-inch and 8,800 feet of eight-inch line, is estimated to be $182,100.

The proposed sewage treatment facility for the City of Carmine could efficiently be located adjacent to Cedar Creek southwest of the inhabited area as shown on Plate CA-6. The proposed plant should be built with a design capacity of approximately 0.05 mgd, at an estimated cost of $76,000, and would serve a population of about 500 people. It is recommended that the plant be of the extended-aeration type of a particular configuration suitable to the City Consideration was given to the use of a system which would include primary treatment, oxidation ponds, and effluent disposal by land application. However, experience has shown that oxidation ponds in the vicinity of the Gulf area tend to become choked with algal blooms. In addition, reference to irrigation records indicated that irrigation is not extensively practiced in the Carmine area probably as a result of soil conditions.

Extended aeration will provide a higher treatment efficiency than oxidation ponds and will minimize the effect of a discharge into the intermittently flowing Cedar Creek. To meet the 1983 requirements of PL 92-500, it is recommended that the overland runoff method of land disposal be initiated. The capital cost for this overland runoff facility is estimated to be $45,440, including 8.5 acres of land, a 2.0 acre holding pond and engineering and contingencies.



LEGEND

— — — PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

CARMINE, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CA-6

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Carmine wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,300, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $71,000, including engineering and contingencies.

Ellinger, Texas.

The City of Ellinger is an unincorporated municipality located in the eastern portion of Fayette County on S.H. 71 approximately 70 miles southeast of Austin, Texas. The inhabited area of the City encompasses approximately 220 acres. Municipal services are supplied by the Ellinger Sewer and Water Corporation which is within the jurisdiction of the CAPCO.

The City has little topographical relief and is drained by the Ellinger branches of Petty's Creek and Duty's Creek. A drainage break occurs along a north-south line through the center of the City. Drainage from this line is west to Petty's Creek and east to Duty's Creek. Elevation variations are about 20 feet, decreasing from the north to the southwest portions of the City.

The major portion of the inhabited area is underlain by soils of the Houston type. This type of soil is generally 6 to 12 inches thick, with a friable, calcareous dry surface overlying a highly calcareous marl clay. This soil is clayey throughout and very plastic and sticky. Permeabilities for the Houston soils are generally less than 0.06 inch per hour and consequently, septic tanks have severe limitations due to the extremely low permeability, and sewage lagoons have slight to moderate limitations depending on the side slopes.

Population data developed by the TWDB for use in this study indicate a rapid decrease in population is expected for Ellinger over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	200	160	130	60

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and

concentration of commercial and public facilities along major thoroughfares in the central areas of the city. The economic resource base is primarily agricultural with some activity generated by tourist-related services along S.H. 71.

The City is accessible by U.S. 71 and is indirectly served by the Missouri-Kansas-Texas Railroad at Fayetteville. Population growth is not anticipated due to the lack of any potential industrial interest or developable natural resource. Construction of the proposed Columbus Bend Reservoir, however, could completely reverse the projected trend and stimulate growth of the area with retirement, weekend, or vacation homes.

The municipal water supply is obtained from a groundwater source. One 75 gpm well comprises the water supply and storage is provided by a 52,000 gallon standpipe. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.02	0.02	0.01	0.01
Industrial Use	None	None	None	None

*Flows in mgd

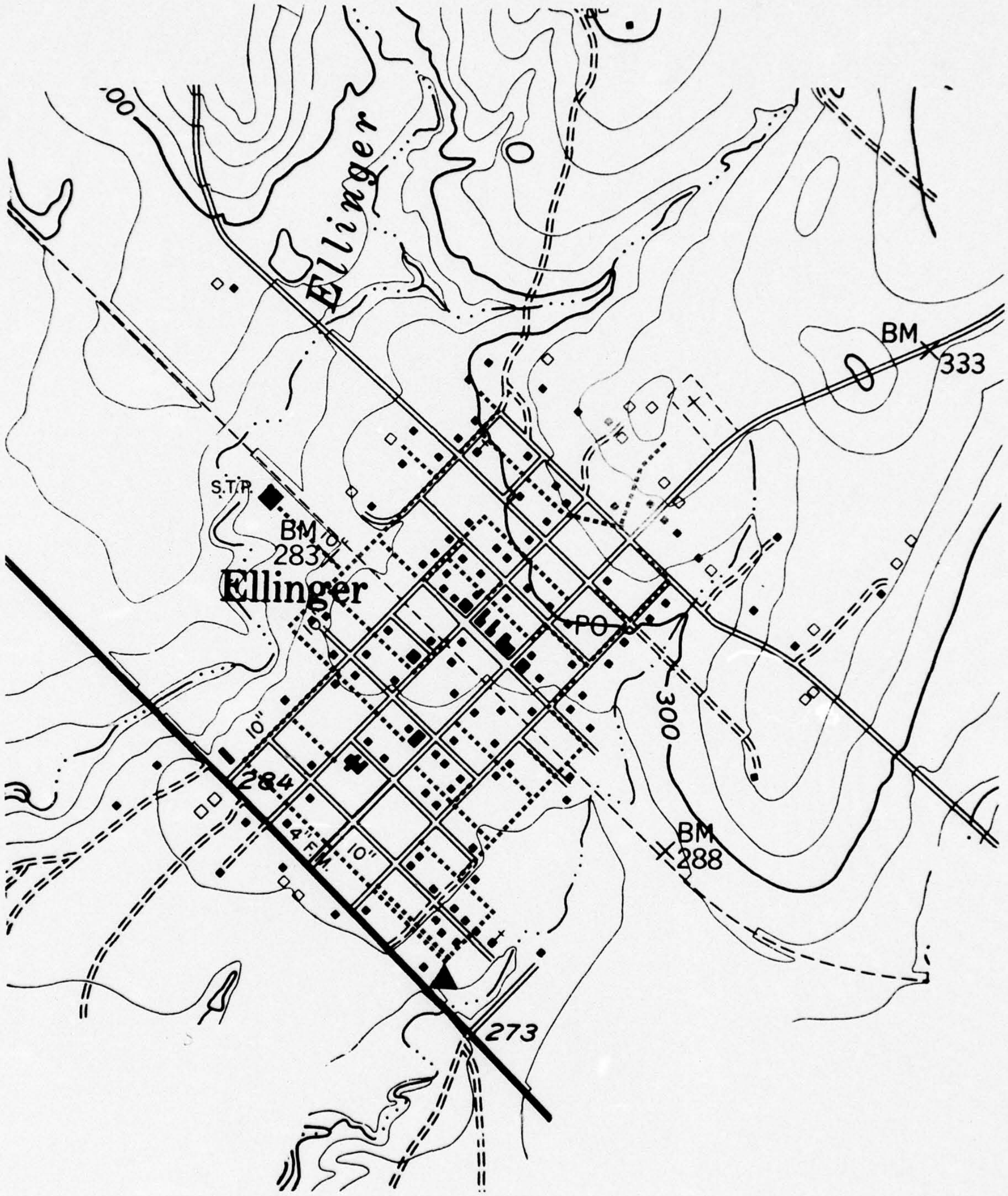
Municipal wastewater return flows have been projected for Ellinger by TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.02	0.02	0.01	0.01
BOD in lb/day	34	29	23	11
TSS in lb/day	40	34	29	14

The existing wastewater collection system is shown on Plate CA-7. It appears that the system is adequate for present needs, and with minor extensions will meet the future needs of the declining population. There are apparently no septic tanks in service in the City, and all wastewater flows to the City's treatment plant.

The existing sewage treatment plant for Ellinger is located west of the inhabited area about 1-1/4 miles northeast of S.H. 71 near the east bank of Petty's Creek on a one-acre tract. The plant was built in 1969 with a



LEGEND

·········· EXISTING SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS
ELLINGER, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 1000' PLATE: CA-7

design capacity of 0.045 mgd, presently serves a population of approximately 200, and has been maintained in good physical condition. The treatment process is a form of extended aeration commonly referred to as a "race track oxidation ditch" and consists of an oxidation ditch, final clarifier, sludge drying beds, and a chlorinator. Available sampling data published by the TSDH and TWQB is as follows:

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	190	190
Raw TSS (ppm)	70	66
Final BOD (ppm)	4	4
Final TSS (ppm)	16	16

Effluent from the chlorinator is discharged into Petty's Creek and sludge is hauled to a landfill site.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, Ellinger is in full compliance with the law. Model studies conducted for this investigation have shown that the discharge from Ellinger will have a negligible impact on the quality of the Colorado River and will result in no violation of existing quality standards. The town is very small and its total discharge so negligible that requirements for higher levels of treatment are unrealistic. Under similar conditions with a town of greater size, it would be proposed that this city irrigate with the effluent or contract with a local farmer to take the water. In this situation, with a return flow of less than 20,000 gallons per day, an irrigation operation could not be justified. It is therefore recommended that no more stringent treatment requirements be imposed on the City and that it be allowed to continue its discharge into the normally dry Petty's Creek.

It is therefore recommended that all steps necessary to implement the aforementioned discharge plan be continued. However, should the City of Ellinger wish to implement a discharge to meet the requirements of PL 92-500 the following items would be required:

1. By 1983, construct total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $64,400, including engineering and contingencies.

2. By 1985, construct denitrification and further phosphorus reduction facilities at an approximate capital cost of $53,000, including engineering and contingencies.

Fayetteville, Texas.

The City of Fayetteville is an incorporated general law city situated in the western portion of Fayette County at the intersection of S.H. 159 and F.M. 1291 approximately 95 miles west of Houston, Texas. The incorporated area of the City encompasses approximately 310 acres and lies within the jurisdiction of the CAPCO.

The land surface slopes from the northwest to the southeast with ground elevations fluctuating from 30 feet. Drainage is provided by two branches of Allen Creek which lie to the northeast and southeast of the City.

Fayetteville is underlain with soils of the Houston-Wilson-Crockett types. These types predominantly have a crumbly, calcareous, clay surface, 6 to 15 inches thick, over subangular, blocky, highly calcareous clay with a highly calcareous clay marl at 20 to 36 inches. The surface soil is very tight and crusty when dry. Permeabilities are less than 0.06 inch per hour imposing severe limitations on septic tanks. There are, however, only slight limitations on sewage lagoons with 0 to 2 percent side slopes and moderate limitations on those with slopes exceeding two percent.

Population data developed by the TWDB for use in this study indicate that a moderate decrease in population is expected for Fayetteville over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	400	330	270	130

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local gravel mining. Accessible by a State highway, the City is served by the Missouri-Kansas-Texas Railroad. Population growth is not anticipated due to the lack of adequate resource availability and economic activity.

The municipal water supply consists solely of ground water resources drawn from two wells with pumping capacities of 250 gpm and 300 gpm. Storage is provided by a ground reservoir with a capacity of 0.063 mg and an elevated reservoir with a capacity of 0.055 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.04	0.035	0.028	0.014
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows projected for the City by the TWQB are as follows

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.04	0.03	0.03	0.01
BOD in lb/day	68	59	49	25
TSS in lb/day	80	69	59	30

The existing wastewater collection system is illustrated on Plate CA-8. The present system has main trunk lines northeast and southeast of town and serves approximately 400 people with 171 connections. All residences within the city limits and approximately five outside the present limits are served by the system. Septic tanks are still the primary means of sewage disposal for a few scattered homes to the north and northeast of the city limits. Due to the distance between homes and the lack of problems with the present facilities, there are currently no plans for abandonment of these facilities. However, should the City choose to extend service to the area, the collector line shown on Plate CA-8 would serve the area. The estimated cost for this line would be $22,300 including engineering and contingencies.

Fayetteville's sewage treatment plant is located 0.5 mile west of the City on Allen Creek. The plant, constructed in 1968, has a stated design capacity of 0.05 mgd and presently serves about 400 people. The facility apparently has been maintained in good condition. The plant is of the contact-stabilization type and consists of a bar screen, a contact basin, clarifier basin, a reaeration aerobic digestor, and a chlorine contact basin. Available sampling data published by the Texas State Department of Health and the TWQB are as follows:

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	80	80
Raw TSS (ppm)	60	59
Final BOD (ppm)	8	8
Final TSS (ppm)	21	21

Sludge is recirculated and effluent from the chlorination chamber is discharged into Allen Creek and eventually to the Colorado River. The only known commercial waste sources in the area that contribute to the system are a small washateria and a local butcher shop which comprise about 10 percent of the total influent to the plant.

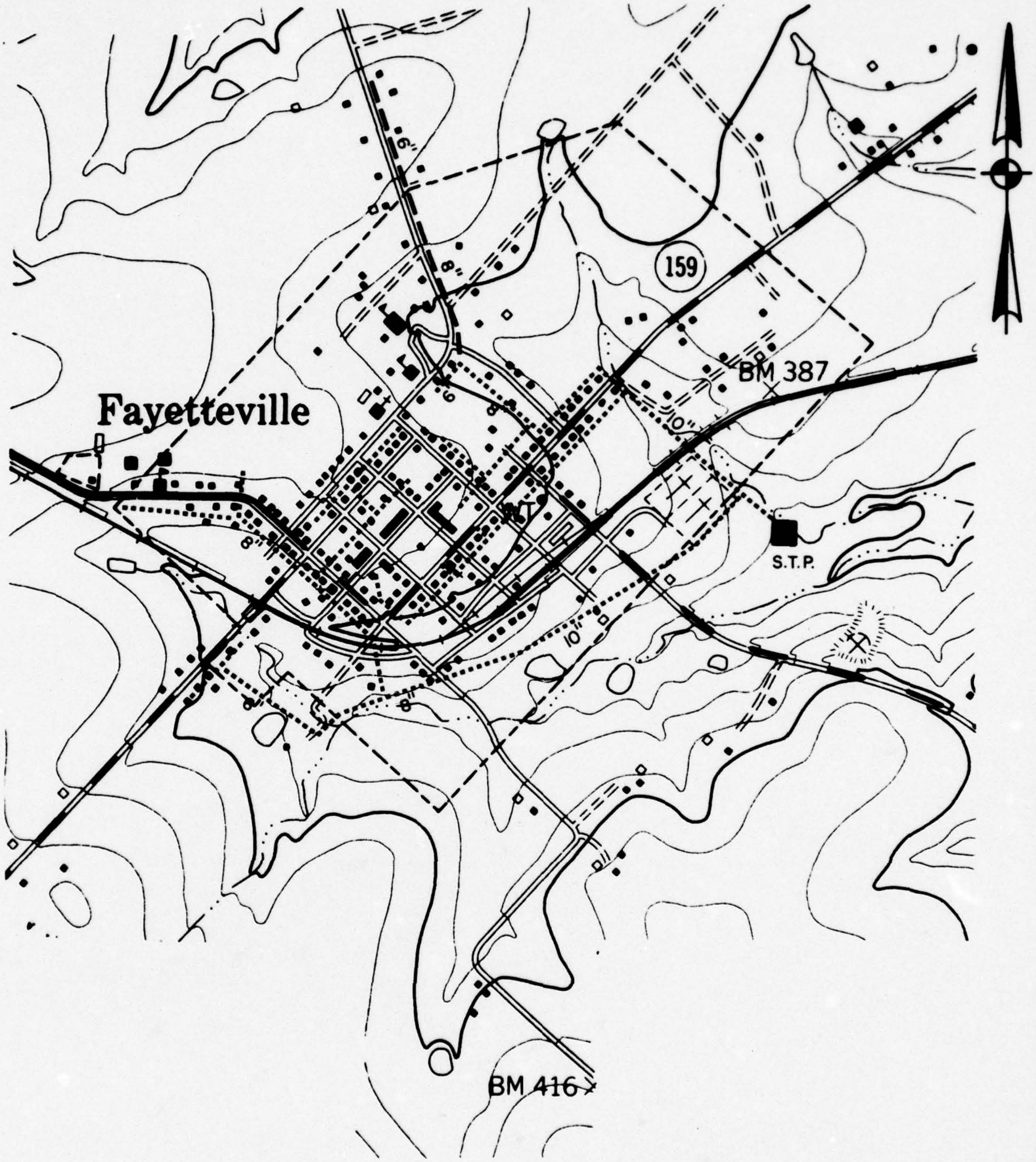
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of the law, the activated sludge plant at Fayetteville meets all secondary treatment requirements of the law and will provide an adequate level of treatment until 1983. Mathematical modeling of the Colorado River below Austin accomplished for this study has indicated that what waste load remains in Fayetteville's discharge upon its eventually reaching the Colorado River would have in insignificant effect on the water quality of the Colorado River.

In order to be in compliance with the 1983 requirements of the law, the City will, however, have to provide a higher level of treatment. Land disposal of effluent by irrigation meets all requirements of the law when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources by runoff or percolation without adequate treatment time.

It is recommended that the City irrigate with the effluent. The City may either enter into agreement with a local farmer who would store and irrigate all flow or the City may own and operate its own irrigation system. The total project costs for a City-owned system to be implemented by 1983, including a 1.5 acre holding pond, irrigation facilities, 7.5 acres of land and engineering and contingencies, are estimated to be $31,600

Savings would be effected by an arrangement whereby the City would use land provided by local farmers. In addition, it may prove cheaper to construct an impoundment in a dry draw than to excavate the holding pond estimated above.

Irrigation has been demonstrated to be an effective method of providing a high degree of final treatment to effluent waters in the Colorado River Basin.



NOTE: ALL UNMARKED LINES ARE 6"

LEGEND

·········· EXISTING SEWER LINES

— — — PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

FAYETTEVILLE, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' PLATE: CA-8

The method has been beneficial to local economies and has eliminated any adverse impacts on the environment that may have been associated with the discharge of a secondary effluent into intermittent streams such as Allen Creek.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Fayetteville wish to implement a discharge plan, the following items would be required:

1. By 1983, construct total filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,400, including engineering and contingencies.

2. By 1985, construct denitrification and further phophorus reduction facilities at an approximate capital cost of $58,000, including engineering and contingencies.

La Grange, Texas.

The City of La Grange is an incorporated general law municipality located in the central portion of Fayette County on the intersection of S.H. 71 and U.S. 77 approximately 65 miles southeast of Austin, Texas. The incorporated area of the City encompasses approximately 1,150 acres. La Grange is the county seat of Fayette County and is a member of the CAPCO.

The City has little topographical relief and is drained by a small draw in the central portion of the City and by direct runoff south to the Colorado River. The City is underlain by soils of the Edge-Tabor Gravelly Fine Sandy Loam and Miller-Yahola-Trinity types. The Edge-Tabor soils are composed 6 to 15 inches of acid surface over very firm and plastic blocky acid clays. The surface soil is crusty and tight when dry, and permeabilities reange from 2.0 to 6.3 inches per hour. Septic tanks are prone to flooding and sewage lagoons have severe limitations due to seepage.

The Miller-Yahola-Trinity soils are generally composed of 10 to 20 inches of crumbly, calcareous clays or fine sandy loams over crumbly, blocky, calcareous clay or calcareous sandy loams. Drainage from these soils varies from moderate to well drained. Permeabilities range from 2.0 to 6.3 inches per hour. Septic tanks are prone to flooding and sewage lagoons are known to have severe limitations due to seepage.

Population data developed by the TWDB for use in this study indicate a very slight population increase over the next 10 years followed by a slight decrease in population for La Grange over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	3,092	3,130	3,040	2,590

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic-resource base is primarily agricultural with some contribution from feed processing, laminated lumber fabrication, and rest homes.

The City is accessible by S.H. 71 and U.S. 77 and is served by the Kansas-Missouri Railroad and the Guenther Airport. Anticipated growth potential is slight due to lack of substantial resource base and outward migration to nearby metropolitan areas.

The municipal water supply is obtained from a ground water source consisting of two wells on the west side of town. Storage for the system is provided by three storage tanks with a total capacity of 0.77 million gallons. The wells' pumping capacities are rated at 1,625 gpm.

The wells serve the City adequately, and no surface water source is required for the municipal water supply. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.43	0.46	0.46	0.44
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	.31	.31	.30	.26
BOD in lb/day	526	563	547	492
TSS in lb/day	618	657	669	596

No industrial point sources are existing or projected for the City and no significance is placed upon the very small amounts of light industrial return flow contributed to the system.

The existing wastewater collection system is shown on Plate CA-9. The system appears adequate to serve the existing serviced population. It is desirable, however, to expand the collection system to serve development south of the river and to provide relief on the southern portion of the collection system with the addition of the relief sewer indicated on the Plate. The cost estimates for these system improvements including relief sewer and outfall, force main, pump stations, and engineering and contingencies are $177,600.

The existing sewage treatment plant for the City of La Grange is located to the west-southwest of the City near the Colorado River. The plant was built in 1953 with a design capacity of 0.268 mgd and presently serves about 3,000 people. It has been maintained in good physical condition. The plant is of the trickling-filter type and consists of an Imhoff tank for primary treatment, a trickling filter, and a final clarifier. Effluent is presently discharged to the river and dried sludges are hauled off to disposal sites. The efficiency of a trickling filter process is such that it is doubtful if the plant could ever meet its permitted level of discharge constituents as presently equipped. Avilable sampling data published by the Texas Department of Health and TWQB is as follows:

Influent-Effluent Data

	TSDH (1971)	TWQB (1969)
Raw BOD (ppm)	150	825
Raw TSS (ppm)	90	118
Final BOD (ppm)	40	200
Final TSS (ppm)	16	34

It has been proposed in earlier reports that the City build a new facility of the activated-sludge type with a capacity of 1.0 mgd. However, population and waste load projections accomplished for this study do not justify facilities of that capacity at any time through the planning period.

It is recommended that a type of activated sludge plant be constructed to replace the trickling filter; however, that facility should be of approximately 0.5 mgd capacity. Since obvious conflict occurs between the growth projections of local engineers and those used for this study, the 0.5 mgd capacity is compromise between the capacity that would be recommended (0.3 mgd) and the anticipation of the local engineers. The total project cost for the 0.5 mgd facility is estimated to be $358,500 including engineering and contingencies. Annual operation and maintenance costs are estimated to be $29,200.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable

waste treatment technology by 1983. It is the present interpretation of the law that an activated-sludge type plant will meet the requirements of "secondary treatment" but that a trickling filter plant will not be capable of producing an effluent with constituent levels at or below those established to define "secondary" treatment.

Although model studies accomplished for this study indicated that no violations of existing stream standards would occur throughout the planning period by discharge of a properly treated secondary effluent from the City of La Grange, the City will be required to upgrade its level of treatment by 1983. At that time the City may either install conventional tertiary waste treatment facilities or may utilize irrigation as the means of final effluent disposal.

Land disposal of effluent has proven to be an efficient method of providing a high degree of treatment of wastewaters throughout the Basin. The City may either contract with local farmers who would store and utilize the water for their crops or the City may wholly own and operate the disposal system. The cost estimates including engineering and contingencies for a city-owned and operated irrigation system are presented as follows. The estimated cost for this system, including a 19-acre 60-day holding pond, irrigation equipment, 51 acres of land, and engineering and contingencies, is $225,800.

Since the apparent impact of the existing level of treatment is negligible, the construction of an activated sludge secondary facility and eventual land application should only further enhance the natural river quality.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of La Grange wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $358,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $145,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $135,000, including engineering and contingencies.

<u>Buda, Texas.</u>

The City of Buda, an incorporated general law municipality, is situated in the eastern portion of Hays County at the intersection of F.M. 2770 and 967,

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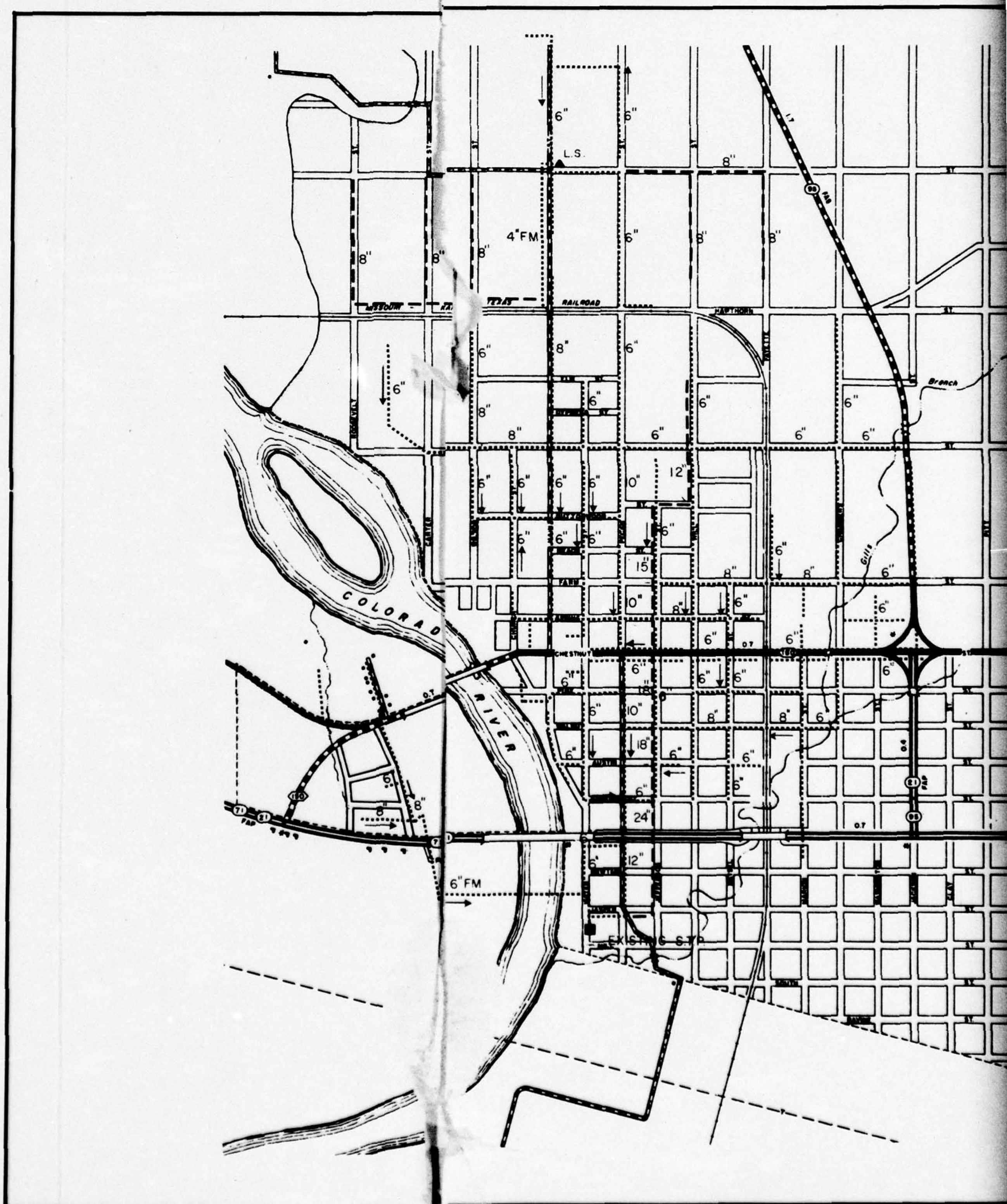
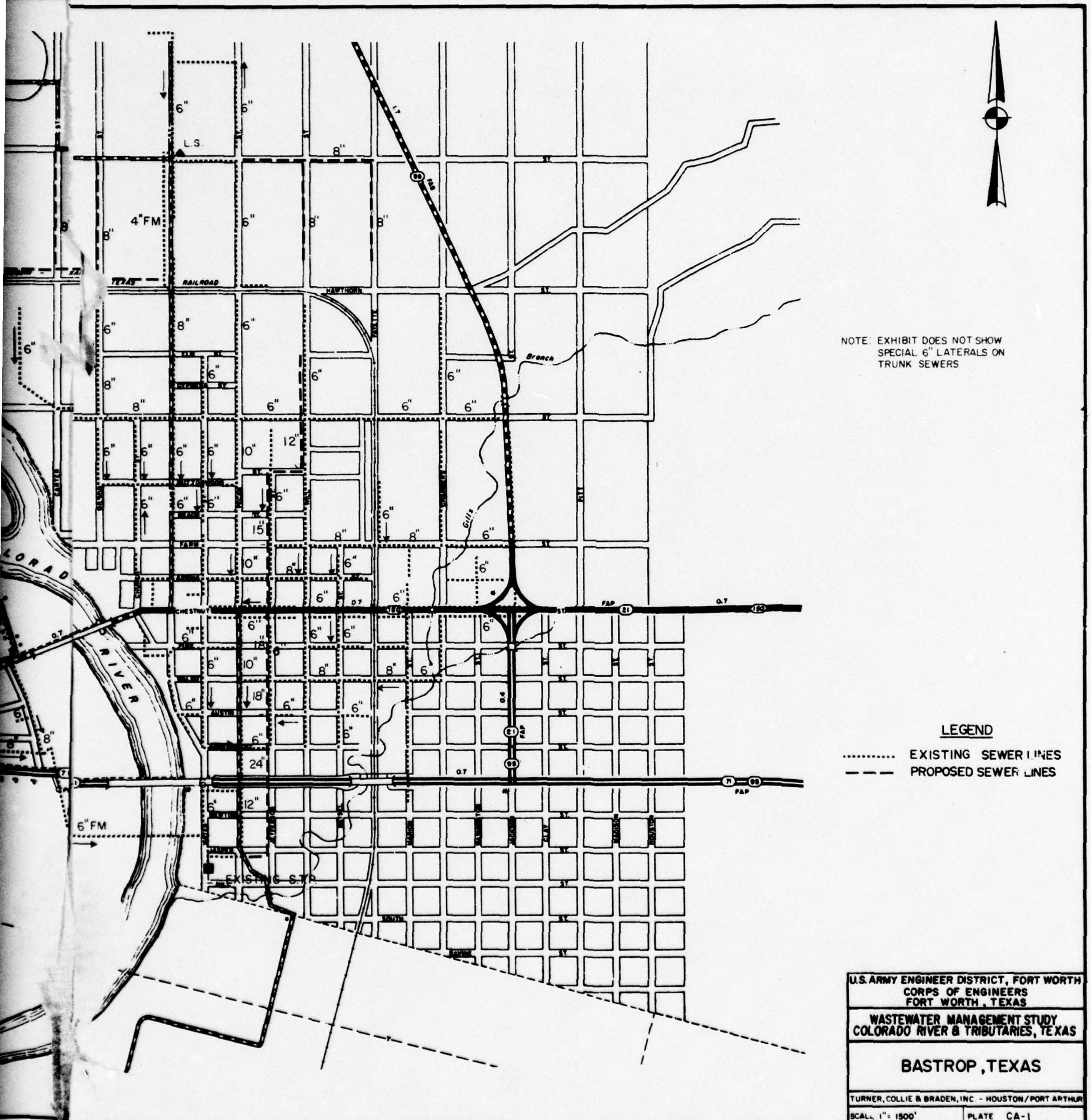



NOTE: EXHIBIT DOES NOT SHOW SPECIAL 6" LATERALS ON TRUNK SEWERS
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES
EXISTING S.T.P.
L.S.
4"FM
6"FM
RAILROAD
RIVER
Branch
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
BASTROP, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE 1" = 1500'
PLATE CA-1

two miles west of I.H. 35 and approximately 10 miles south of Austin, Texas. The incorporated area encompasses approximately 245 acres. Buda is located within the jurisdiction of the CAPCO.

The City drains to the northeast with ground elevations decreasing approximately 30 feet in that direction. Onion Creek, bordering the town on the east, provides the outfall for the drainage.

The City is completely underlain by Houston Black-Houston clays. These soils generally have a crumbly, friable, calcareous, clay surface, 10 to 25 inches thick, over firm, subangular, blocky, calcareous clay. Permeabilities are less than 0.06 inch per hour. Septic tanks have severe limitations due to the slow permeability. Sewage lagoons have slight limitations on a 0 to 2 percent slope and moderate limitations on slopes greater than two percent.

Population data, developed by the TWDB for use in this study, indicate that a slight increase in population is expected for Buda over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	498	550	610	720

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no known contribution from industry.

Accessible by an Interstate highway, the City is served by the Missouri and Pacific Railroad. Anticipated population growth is fair due to the proximity of Austin.

Municipal water supply consists solely of ground water supplies drawn by one well with a pumping capacity of 250 gpm. Storage is provided by a ground reservoir with a capacity of 0.130 mg and an elevated storage tank with a capacity of 0.05 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	.049	.062	.071	.088
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB, are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	.05	.06	.06	.07
BOD in lb/day	85	99	110	137
TSS in lb/day	100	116	134	166

The existing wastewater collection system is illustrated on Plate CA-10. The trunk lines in the system should be adequate until 2020; however, some laterals will need to be added about 1980 as shown on Plate CA-10. The estimated cost for the proposed collection system improvements, including 6,700 feet of eight-inch line and engineering and contingencies, is $78,000. There is no area of the City where septic tanks arre still the primary means of sewage disposal; however, there are approximately 15 residences outside of the city limits which are not served.

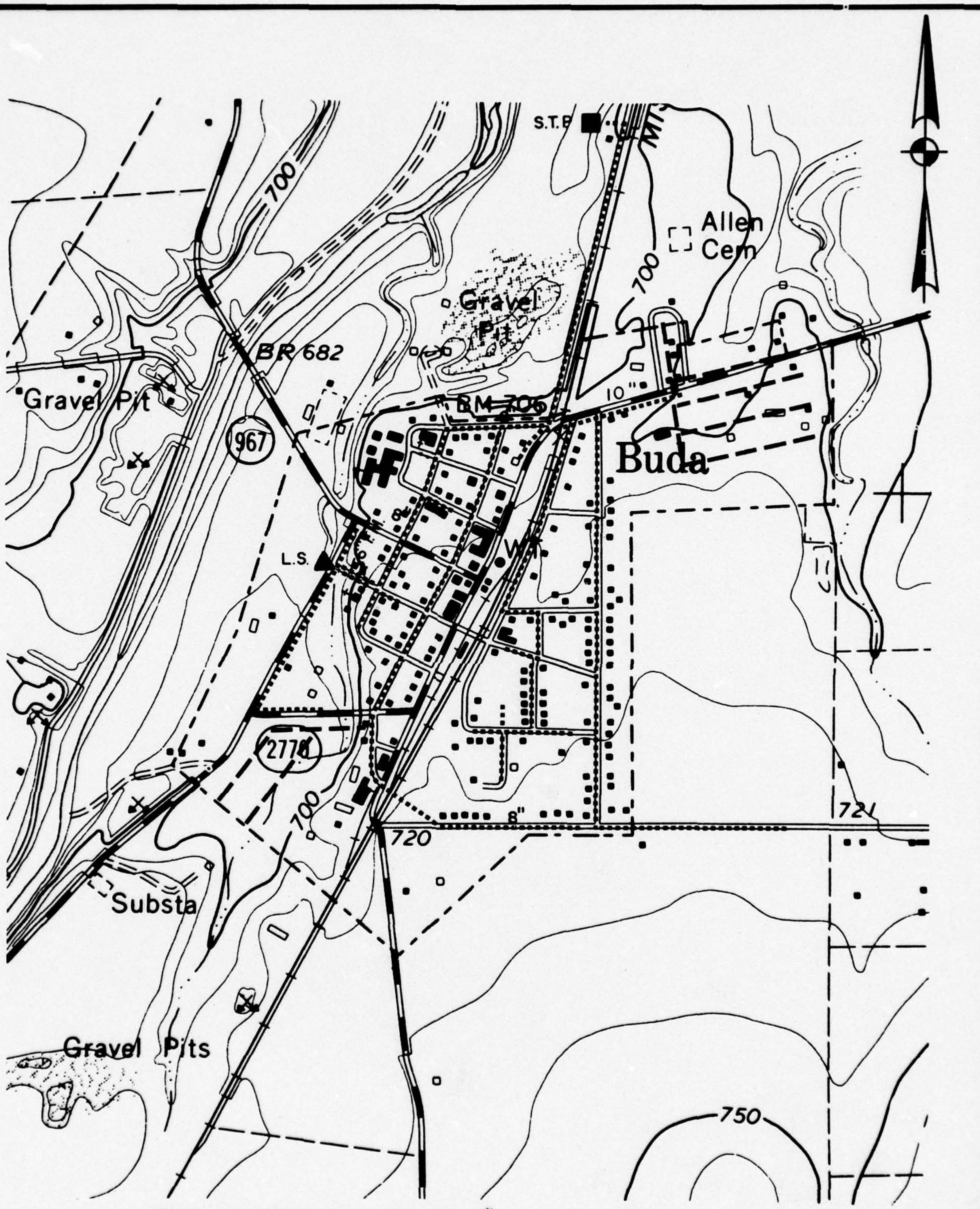
Buda's existing sewage treatment plant is located north of the City. The plant, constructed in 1970, with a design capacity of 0.070 mgd, presently serves about 500 people through 160 sewer connections. The plant is of the Imhoff-oxidation pond type consisting of a bar screen, grit chamber, Imhoff tank, sludge drying beds, three oxidation ponds, and a chlorination chamber. Available sampling data published by the Texas State Department of Health and theTWQB are as follows:

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	150	150
Raw TSS (ppm)	200	198
Final BOD (ppm)	25	25
Final TSS (ppm)	125	125

Sludge disposal consists of utilizing the dried material as fill at the plant site. There has been no surface discharge from the plant since its construction. Apparently all of the flow entering the first oxidation pond is either evaporating or seeping into the gravel subsurface.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best



NOTE: ALL UNMARKED LINES ARE 6"

LEGEND

....	EXISTING SEWER LINES
— — —	PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BUDA, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CA-10

available technology economically achievable by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate treatment time.

The capacity of the existing sewage treatment plant should be adequate throughout the study period with no expansions. It is recommended that the effluent from the ponds be used to irrigate all or part of a 40-acre pasture located north of the treatment plant. Assuming the overland runoff method of land disposal, a land area of about 10 acres would be required for the year 2020 projected population of 720.

The existing sewage effluent ponds are located over 1,000 feet from the bank of Onion Creek. Assuming that some of the effluent from the ponds seeps into the gravel which underlies the plant site at a depth of about 10 feet, it would have to travel at least 1,000 feet before reaching Onion Creek. According to the "Assessment of the Effectiveness and Effects of Land Disposal Methodologies of Wastewater Management," Department of the Army Corps of Engineers, Report 72-1, page 8, several hundred feet of contact would be required to effectively renovate effluent disposed of in this manner (rapid infiltration method of land disposal). Therefore, there should be no danger of this occurrence threatening the water quality of Onion Creek.

No sewage treatment facilities are proposed in this report for the City of Buda, based on present conditions and projections. Although it is recommended that the City begin a program of land disposal of the plant effluent, this is to be accomplished by means of an agreement between the City and the individual who owns the adjacent pastureland to be used.

It is therefore recommended that the aforementioned no-discharge plan be undertaken. However, should the City of Buda wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $95,200, including engineerng and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.

Dripping Springs, Texas.

The City of Dripping Springs, an unicorporated general law municipality, is located in the northern portion of Hays County at the intersection of U.S. 290 and F.M. 12 approximately 25 miles west of Austin, Texas. The inhabited area of the City encompasses approximately 101 acres and lies within the jurisdiction of the CAPCO.

The topographic relief of Dripping Springs is slight with the land gently sloping to the south. Two branches of Onion Creek bordering the eastern and western limits of the City provide drainage.

The City is completely underlain by Brackett-Tarrant Stony Clays. The Brackett soil type, generally three to eight inches thick, is a calcareous clay with numerous limestone fragments over a friable, granular, calcareous clay containing many large limestone fragments and discontinuous strata interbedded with limestone. The Tarrant soil has a friable, highly calcareous, clay surface, generally four to eight inches thick, over broken or partly weathered limestone or limestone bedrock. Surface permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks and sewage lagoons have severe limitations due to the shallow depth of the bedrock.

Population data developed by the TWDB for use in this study indicate that a slight increase in population for Dripping Springs is expected over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	495	550	610	720

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is primarily based on livestock production with some contribution from local gravel operations.

A large consolidated school located in the City provides employment for many residents and has probably the single largest payroll in the town.

Accessible by U.S. 290 and F.M. 12, the City is likely to feel the growth of the nearby Austin metroplitan area. As such, continual growth is anticipated as commuter, weekend, and vacation homes reach out from the metro area.

The municipal water supply is obtained solely from a ground water source. The water is drawn from a well five miles south of town by a pump with a capacity of 150 gpm. Storage is provided by a ground

reservoir and a stand pipe reservoir with capacities of 0.026 mg and 0.050 mg respectively. The anticipated water use, as reflection of the population trend, has been projected by the TWDB to as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.05	0.05	0.06	0.07
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.05	0.06	0.06	0.07
BOD in lb/day	84	99	110	137
TSS in lb/day	99	116	134	166

Due to the absence of an existing wastewater collection and treatment system, the only means of waste disposal utilized are septic tanks and privies. However, because of the large waste loads associated with the school and if the projected populations are realized, the City may be required to install a different method of waste disposal. Should the population concentration increase, the resulting increased waste load may overburden the soil's capacity thus causing the septic tanks to become public nuisances and possible health hazards.

A proposed wastewater collection system for the City of Dripping Springs is presented on Plate CA-11. The total project cost for the system, including 6,900 feet of 6-inch line, 13,150 feet of 8-inch line, and engineering and contingencies, is estimated to be $216,900.

The location of a proposed wastewater treatment plant is shown on Plate CA-11. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the constituent levels which will be utilized to define secondary treatment can be attained by the implementation of a 0.07 mgd secondary treatment facility by 1975 that would be of the activated-sludge type operated in either the extended aeration or contact

stabilization mode. It is estimated a facility of this size would cost $95,200 including engineering and contingencies and could accommodate the projected waste loads through year 2020 for the City. It is proposed that effluent from the treatment plant should be disposed of entirely through irrigation by 1983 to be in compliance with the law. Also within the present interpretation of the law, irrigation or land disposal of effluent as proposed meets all treatment requirements of 1977 and through 1985 when the disposal is executed in an approved manner and when no effluent is introduced into surface water or ground water resources either by direct runoff or percolation without adequate treatment time.

Should the City choose to dispose of all effluent by irrigation, two institutional alternatives are available. The City may either contract with a local farmer who would take all effluent and provide all irrigation facilities, or the City may own and operate the system. The total project cost for a city-owned and operated system, including a 2.6-acre holding pond, irrigation equipment, 17.6 acres of land and engineering and contingencies, is estimated to be $57,000.

If arrangement can be made with local farmers to either take the water or allow the City to use their land, some costs such as land acquisition can be greatly reduced. In addition, some economies can be affected by choice of the impoundment location; a dry small draw could be made into a reservoir for substantially less than the estimated cost.

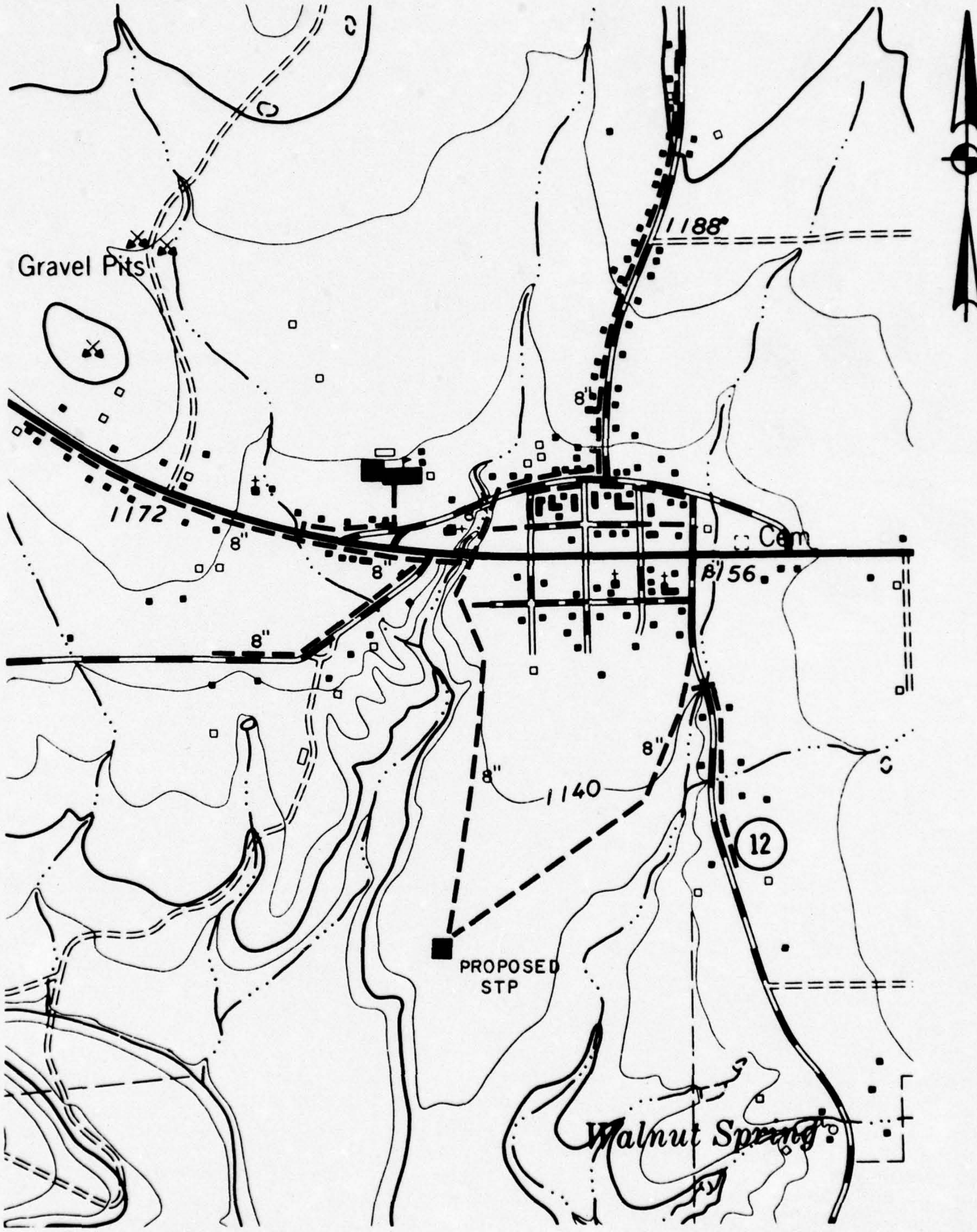
Utilization of effluent for irrigation purposes has been found to be a particularly viable means of wastewater disposal in many areas of the Colorado River Basin and has proven a valuable reuse of a scarce natural resource. The method also eliminates any adverse impact on receiving watercourses that may be associated with the discharge of a secondary effluent.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Dripping Springs wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $95,200, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.



NOTE: ALL UNMARKED LINES ARE 6"

LEGEND

— — — PROPOSED SEWER LINES

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

DRIPPING SPRINGS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: CA-11

Giddings, Texas.

The City of Giddings, an incorporated general law municipality, is situated in the south central portion of Lee County at the intersection of U.S. 290 and U.S. 77 approximately 50 miles east of Austin, Texas. The incorporated area of the City encompasses approximately 1,660 acres of which approximately 1,300 acres are in the study area. Giddings, the county seat of Lee County, is located within the jurisdiction of the CAPCO.

The northern portion of the City lies in the Brazos River Basin, while the southern portion is in the Colorado River Basin. The southern portion of the City slopes to the south with ground elevations decreasing approximately 40 feet in that direction and is drained by Sandy Creek and Rabbs Creek. The northern portion, which slopes to the north, is not within the study area.

The City is underlain by Edge-Lufkin-Tabor fine sandy loams. These soils have an acid surface, 4 to 12 inches thick, over a very firm, compact, blocky, acid, clay grading with depth into a clay or sandy clay. The surface soil is crusty and tight when dry. Permeabilities are less than 0.06 inches per hour. There are severe limitations on septic tanks and slight limitations on sewage lagoons due to the slow permeability of the soil.

Population data, developed by the TWDB for use in this study, indicate that a slight increase, followed by a slight decline, in population is expected for Giddings over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,088	2,250	2,330	2,180

These population projections represent 75 percent of the total existing and projected figures. At present there are 457 sewer connections tributary to the north plant and 546 sewer connections tributary to the south plant. Of the 457 connections to the north system, 416 are residences and 41 are commercial, and of the 546 connections to the south plant 398 are residential and 148 are commercial. The estimated population tributary to the north plant in 1972 was 1,240 (not including two nursing homes which vary between 150 and 200 people) and the estimated population tributary to the south plant in 1972 was 1,483. When 200 people are assumed to reside in the two nursing homes (making the total 1972 population tribtuary to the north plant 1,440), the population distribution between the north and south plants is almost even. For the purpose of this study, it will be assumed that 50 percent of the total population throughout the study period will be tributary to each of the two plants (the north and south plants) as follows:

Population Projections

Year	1970	1980	1990	2020
Population (each plant)	1,392	1,500	1,554	1,453

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with a boat manufacturing plant being the only industrial contribution. Giddings is the site of a new State School for Boys and a new State Seed Laboratory. Accessible by two U.S. highways, the City is also served by the Southern Pacific Railroad and an airport. Growth potential is slight due to limited developable resources.

The municipal water supply is obtained from ground water sources by four wells with pumping capacities of 162, 178, 210, and 510 gpm. Storage is provided by two ground reservoirs with capacities of 55,000 and 300,000 gallons. No surface water resources are utilized for the municipal water supply. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.50	0.60	0.66	0.72
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB, are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.21	0.22	0.23	0.22
BOD in lb/day	355	405	419	414
TSS in lb/day	418	472	513	501

These waste load projections are based on the 75 percent population projection figures as previously mentioned. Dividing these numbers by 0.75 results in the following waste load projections for the entire City:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.28	0.30	0.31	0.29
BOD in lb/day	473	540	559	552
TSS in lb/day	557	629	684	668

As was in the case for the population projections, it will be assumed that 50 percent of the above waste load projection figures will apply to both the north and south plants, as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.14	0.15	0.16	0.15
BOD in lb/day	237	270	280	276
TSS in lb/day	279	315	342	334

The existing wastewater collection system is illustrated on Plate CA-12. There are no areas inside of the city limits where septic tanks are used for sewage disposal.

There are three existing sewage treatment plants in Giddings as shown on Plate CA-12. One of the plants in is the northern section of town and drains out of the study area into the Brazos River Basin. The other two plants, one serving the City and the other serving the State School for Boys, are in the southern section of town and are described below.

The south plant, constructed in 1958, has a design capacity of 178,000 gallons per day and is maintained in good physical condition. The plant is of the Imhoff-oxidation pond type and consists of an Imhoff tank, sludge drying beds, and two oxidation ponds. Available sampling data published by the Texas State Department of Health and the TWQB are as follows:

Influent-Effluent Data

	TSDH (1971)	TWQB (1970)
Raw BOD		105
Raw TSS		95
Final BOD	45	25
Final TSS	55	161

Sludge disposal consists of spreading the dried material around the oxidation ponds. Effluent is occasionally utilized for irrigation purposes, but generally is discharged into Sandy Creek.

The sewage treatment plant serving the State School for Boys is located approximately two miles east of Giddings as shown on the inset on Plate CA-12. The plant was constructed in 1972 with a design capacity of 115,000 gallons per day and presently served approximately 400 boys and 40 employees. It is in new structural and mechanical condition. The plant is of the activated-sludge type consisting of a bar screen, aeration tank, clarifier, digestor, sludge holding tank, and a chlorine contact chamber. Since the plant is new, there are no available sampling data. Sludge will be spread around the plant. Effluent is discharged into Cummins Creek.

Presently there are plans to utilize the secondary effluent from the boys school plant to irrigate part of approximately 100 acres adjacent to the plant. The individual who owns the land plans to construct the necessary application equipment to irrigate pasture land. This size tract is more than adequate to renovate the effluent from this plant assuming the overland runoff method of land disposal. Since the treatment plant was designed to serve a designated number of people for which the school was constructed, no future expansions to either the school or plant can be anticipated at this time. Therefore, it is assumed that the secondary treatment facilities followed by land disposal of the effluent will be adequate throughout the study period.

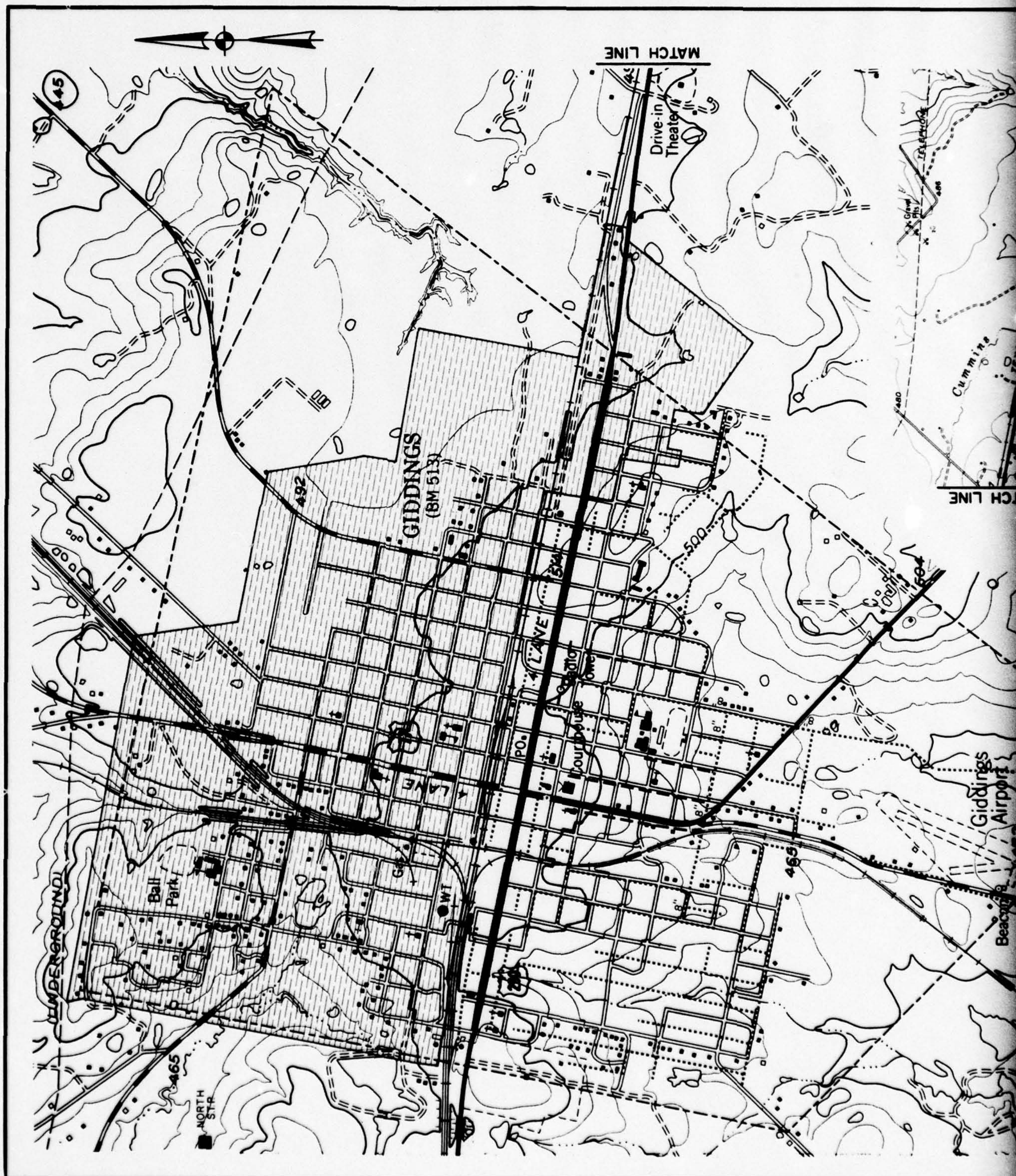
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Giddings State School for Boys wish to implement a discharge plan, the following items would be required:

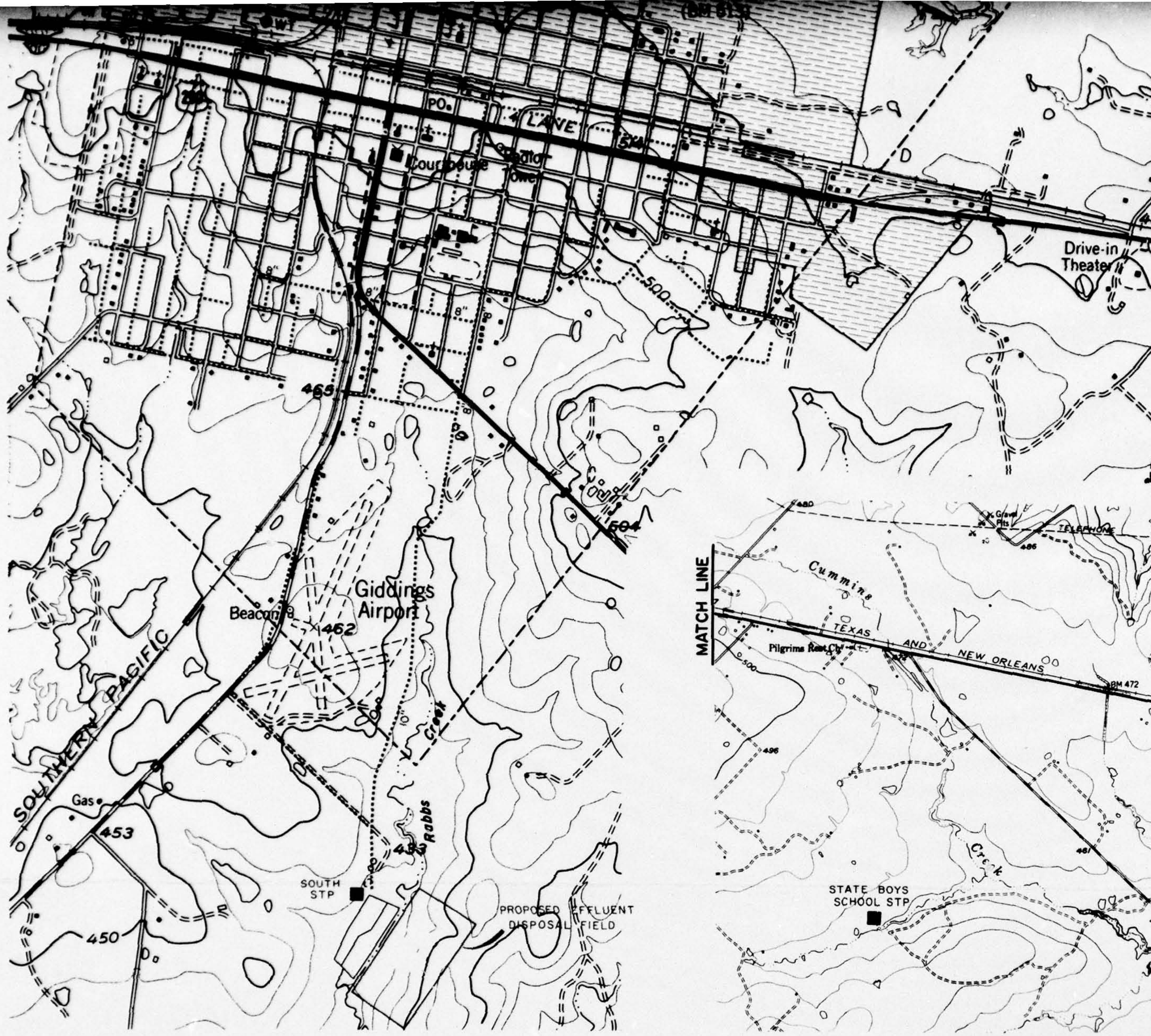
1. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $97,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $77,000, including engineering and contingencies.

Under requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977, and the best available technology economically achievable by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate treatment time.

The collection system is adequate to serve existing development, and will require only minor expansion about 1980, as shown on Plate CA-12. The


MATCH LINE
Drive-in Theater
GIDDINGS
(BM 513)
LANE
Courthouse
P.O.
Giddings Airport
Ball Park
UNDERGROUND
NORTH STR.
Cummins
500
492
465
45
MATCH LINE



NOTE: ALL UNMARKED LINES ARE 6"

LEGEND

- ········ EXISTING SEWER LINES
- — — — PROPOSED SEWER LINES
- AREA SERVED BY NORTH PLANT (BRAZOS RIVER BASIN)

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS
GIDDINGS, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1500' PLATE CA-12

2

cost of the proposed collection improvements including engineering and contingencies and 5,800 feet of eight-inch line, is estimated to be $67,700.

The existing south sewage treatment plant has adequate capacity to serve throughout the study period. Although primary treatment is accomplished by means of an Imhoff tank (not assumed to meet the requirements of adequate primary treatment in this report), the effluent is planned to be used for land disposal. There is a 30-acre tract just across Rabbs Creek from the treatment plant site which will use effluent from the final oxidation pond to irrigate pasture grass on a permanent year-round basis. Assuming the overland runoff method of land disposal and an application rate of two inches per week (adopted as standard in this report), the existing tract of land would be adequate to renovate the secondary effluent from a population of 2,500 and would therefore be adequate throughout the study period.

The oxidation ponds have a surface area of approximately six acres and assuming a depth of four feet, would hold approximately 7.8 million gallons. The existing capacity of these ponds would be adequate to hold the effluent discharged from the south plant, assuming a 1990 flow of 160,000 gallons per day for 49 days without a discharge (ignoring net evaporation). Although oxidation ponds do not meet the requirements for adequate secondary treatment set forth in this report, since land disposal is proposed for the effluent, no conventional secondary treatment facilities are proposed herein for Giddings.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Giddings wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $175,200, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $121,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $84,000, including engineering and contingencies.

Llano, Texas.

The City of Llano, an incorporated general law municipality, is situated in the north central portion of Llano County at the intersection of S.H. 16 and S.H. 29 approximately 75 miles northwest of Austin, Texas. The incorporated area encompasses approximately 1,660 acres. Llano, the county seat of Llano County, is located within the jurisdiction of the CAPCO.

The City is divided into northern and southern portions by the Llano River. The northern portion sloping to the south is drained by Buttery Creek, which flows through the City and the southern portion drains to the north directly into the Llano River.

The City is underlain by the Tishomingo-Pontotoc soils. These soils have a very friable, slightly acid, sandy loam to loam surface, 5 to 12 inches thick, over friable to firm, sandy clay, over partly weathered granite or gneiss at depths of 10 to 30 inches beneath the surface. Permeabilities are less than 0.05 inch per hour. Septic tanks have severe limitations due to the slow permeability, and sewage lagoons have severe limitations due to the shallow depth of the bedrock.

Population data developed by the TWDB for use in this study indicate that a moderate increase in population is expected for Llano over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,608	2,960	3,360	4,520

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some industrial contribution in the form of stone processing plants and a locker plant. Accessible by two State highways, Llano is served by the Southern Pacific Railroad and by an airport.

The municipal water supply source is the Llano River. Raw water is pumped from the river by means of three horizontal centrifugal pumps having a total pumping capacity of 3,400 gallons per minute. After treatment by coagulation, sedimentation, filtration, and chlorination, water is stored in a 310,000 gallon ground storage tank. Water is supplied to the distribution system from the ground storage tank by means of four pumps having a total capacity of 3,300 gallons per minute. There are also three elevated storage tanks on the system with capacities of 100,000, 75,000 and 168,000 gallons. Approximately 1,300 water connections are served by this system at present.

The projected water use, a reflection of the population trend, has been projected by the TWDB, to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.64	0.77	0.90	1.30
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB, are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.26	0.30	0.34	0.45
BOD in lb/day	443	533	605	859
TSS in lb/day	522	622	739	1,040

The existing wastewater collection system is illustrated on Plate CA-13.

The system is apparently adequate for present needs although approximately 100 houses on the north and west sides of town utilize septic tanks as the primary means of sewage disposal.

It is recommended that the proposed sewage collection lines as shown on Plate CA-13 be constructed to serve present and future development in Llano. The lines proposed for construction by 1975 will serve existing areas now using septic tanks, as mentioned above, while those proposed by 1990 will serve future development. The cost for the collection system improvements proposed for 1975, including lift stations, 52,600 feet of 8-inch line, 1,900 feet of 10-inch line, 4,500 feet of 15-inch line, 3,300 feet of 4-inch force main, 3,000 feet of 10-inch force main and engineering and contingencies, is estimated to be $1,227,200. The cost for the collection system improvements proposed for 1990, including 25,100 feet of 8-inch line, 8,000 feet of 10-inch line and engineering and contingencies, is estimated to be $574,000.

Llano's existing sewage treatment plant is located on the south bank of the Llano River on the west side of the City. The plant, constructed in 1947, is of the Imhoff-oxidation pond type and consists of a Parshall flume, grit chamber, a bar screen, Imhoff tank, flow meter, sludge drying beds, a lift station, and two five-acre oxidation ponds. The plant is maintained in good physical condition and presently serves about 2,600 people and a locker plant.

Available sampling data published by the Texas State Department of Health and the TWQB are as follows:

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)		105
Raw TSS (ppm)		149
Final BOD (ppm)	60	20
Final TSS (ppm)	85	89

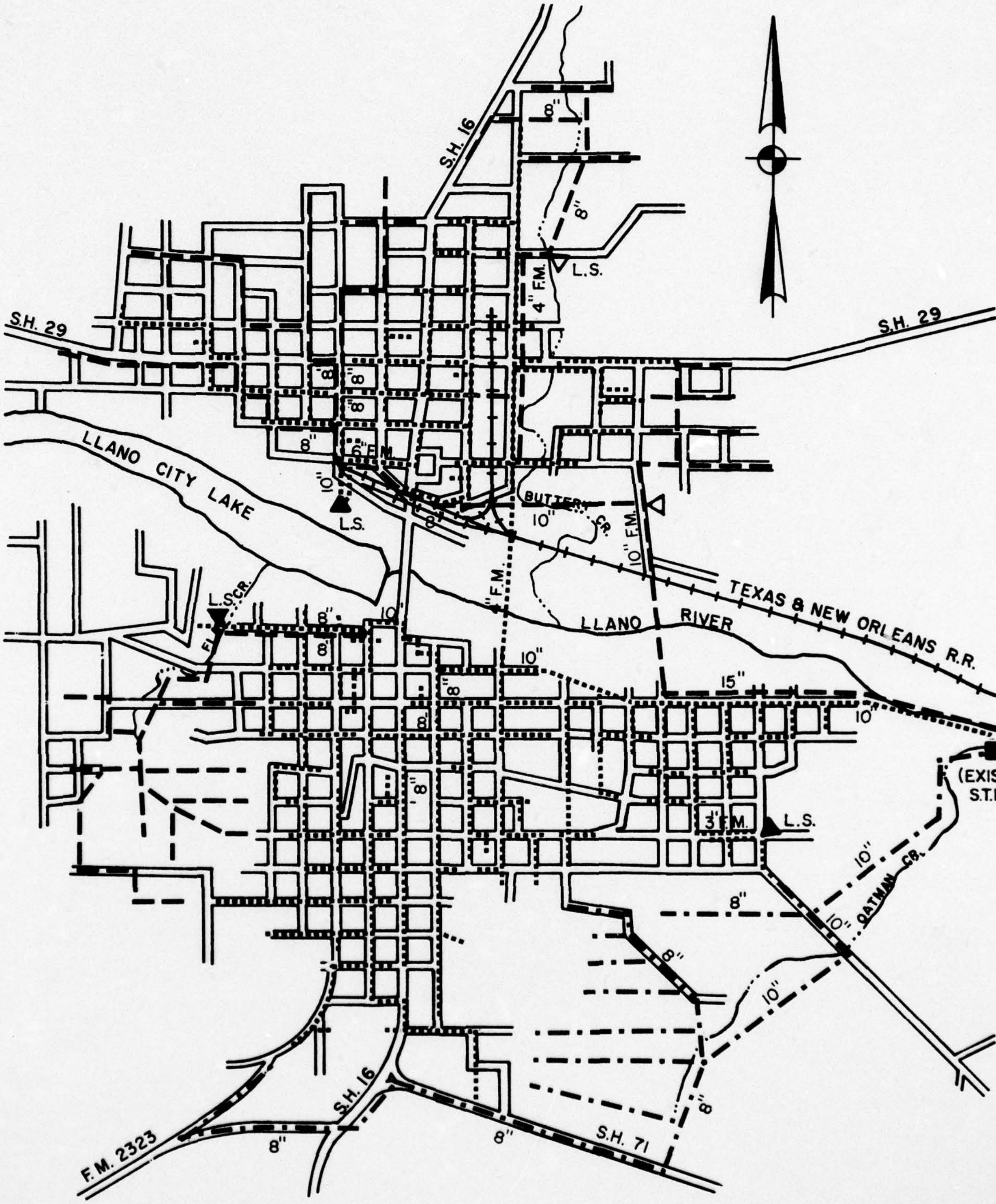
Sludge disposal consists of hauling the dried material to pastures and utilizing it as fill around the plant. Effluent is used in part for a spray irrigation purposes nine months of the year on a privately owned 40-acre tract. The other three months of the year it is discharged into the Llano River. The only contributing industrial wastewater source to the sewage treatment plant is a small locker plant. Filter backwash water and sludge from the City's water treatment plant settling basin are discharged into the Llano River twice annually.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best available technology economically achievable by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or by percolation, without adequate treatment time.

According to population and municipal return flow data, the existing secondary sewage treatment facilities are adequate to serve throughout the study period. Although the Imhoff tank and oxidation ponds will not provide adequate primary and secondary treatment under the standards adopted for this report, land disposal of the effluent is recommended on a full-time basis with no discharge being allowed from the ponds to directly enter the Llano River. Therefore, conventional primary and secondary treatment is not proposed herein to replace these existing facilities.

Assuming a depth of four feet for the ponds, they have a capacity to hold approximately 13 million gallons. This capacity would be adequate to hold the projected year 2020 wastewater flow with no discharge for 29 days (ignoring the effect of net evaporation).

Utilizing the overland runoff method of land disposal, the existing 40-acre tract assumed available for this purpose would be adequate to renovate the secondary effluent from a population of 2,900 people using an application rate of two inches per week. From population projections, this land area



LEGEND

EXISTING SEWER LINES
PROPOSED SEWER LINES 1975
PROPOSED SEWER LINES 1990

NOTE: ALL UNLABELED LINES ARE 6"

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COLORADO RIVER & TRIBUTARIES, TEXAS

LLANO , TEXAS

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SCALE 1" = 1000' | PLATE: CA-13

would be adequate until about 1980, at which time an additional 22 acres of land will be required to be adequate until year 2020. The expansion to these facilities in 1980 will require 22 acres of land, an effluent distribution line pump, 1,500 feet of six-inch distribution and an Aquatower sprinkler, at an estimated cost of $66,240, including engineering and contingencies.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Llano wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $157,360, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $164,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $131,000, including engineering and contingencies.

<u>Del Valle</u>.

The community of Del Valle is located just southeast of the City of Austin between S.H. 71 and the Colorado River, and just north of Bergstrom Air Force Base. The community is in Travis County and therefore under the jurisdiction of the CAPCO.

Population projections for Del Valle as furnished by the TWDB are presented below:

Population Projections

Year	1970	1980	1990	2020
Population	300	390	480	810

The community is served by the City of Austin water distribution system. Most of the area is served by septic tanks, although there are a few connections to the City of Austin interceptor which passes through the community transporting domestic sewage from Bergstrom Air Force Base to the Hornsby Bend oxidation ponds on the north side of the Colorado River.

It is recommended that the community construct the sewage collection system as shown on Plate CA-14 by 1975 tributary to the Bergstrom Air Force Base interceptor. The estimated cost of the collection system improvements

including 14,500 feet of 8-inch line, 4,500 feet of 4-inch force main, and two lift stations, is approximately $203,800 including engineering and contingencies.

It is recommended that the City contract with the City of Austin and initiate the regionalization of their wastewater into the Austin system. Should the City of Del Valle wish to implement a separate discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $68,710, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen reduction facilities at an approximate capital cost of $72,300, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate captial cost of $71,000, including engineering and contingencies.

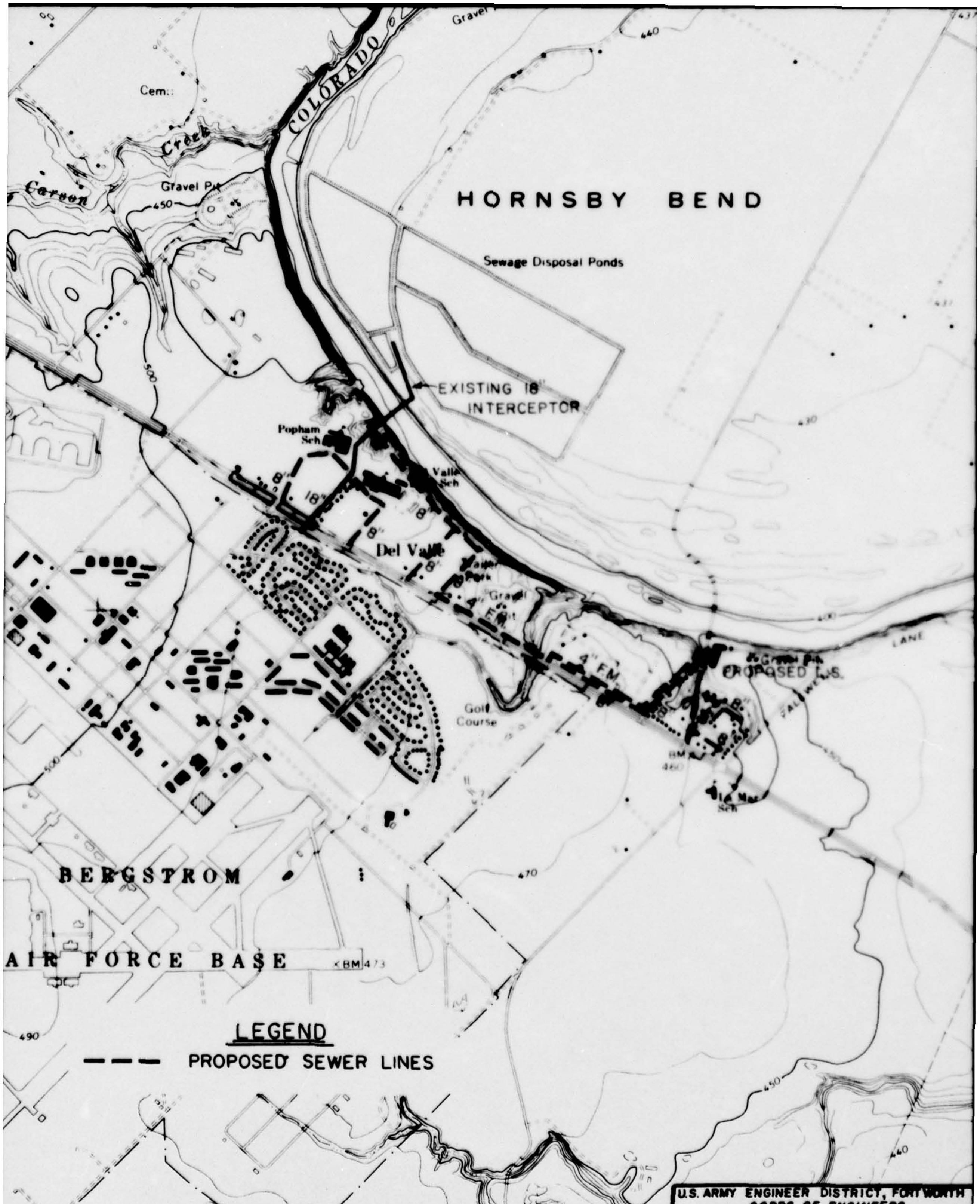
<u>Manor, Texas</u>.

The City of Manor, Texas, an incorporated general law municipality, is situated in the eastern portion of Travis County at the intersection of U.S. 290 and F.M. 973 approximately 10 miles east of Austin, Texas. The incorporated area encompasses approximately 300 acres. The City is within the jurisdiction of the CAPCO.

The City rests on a ridge bordered by Wilbarger Creek on the northeast and Gilleland Creek on the southwest. The land slopes southwesterly, draining into the Gilleland Creek watershed.

The City is predominantly underlain by soils of the Houston Black-Houston type. These soils are generally very deep, well-drained, very slowly permeable, calcareous clay. When dry, cracks ranging in widths from 0.4 to four-inches in width may appear to a depth of 20 inches. This soil is clayey throughout and very sticky and plastic. Permeability for Houston-Black-Houston soils is less than 0.06 inch per hour. Septic tanks, therefore, have severe limitations due to the extremely slow permeability and sewage lagoons would have slight to moderate limitations depending on the side slopes due to the cracking problems.

Population data developed by the TWDB for use in this study indicate a moderate increase in population is expected for Manor over the next 50 years. The population projections are as follows:



HORNSBY BEND
COLORADO
Sewage Disposal Ponds
EXISTING 18" INTERCEPTOR
Popham Sch
Valle Sch
Del Valle
Golf Course
PROPOSED L.S.
BERGSTROM
AIR FORCE BASE
Gravel Pit
Gravel Pits
Cem
Creek
Carson
LEGEND
PROPOSED SEWER LINES
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
DEL VALLE, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 2000'
PLATE: CA-14

Population Projections

Year	1970	1980	1990	2020
Population	940	1,180	1,440	2,400

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with no significant industrial contribution.

The City is accessible via U.S. 290 and is served by the Southern Pacific Railroad. Indirectly, Manor is served by Austin's Robert Mueller Municipal Airport, only about eight miles west of Manor. Anticipated growth potential is favorable due to the City's close proximity to Austin.

The municipal water supply is obtained from a well. The water is hot and first cooled in a ground storage tank before being introduced into the City system.

The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.08	0.10	0.13	0.21
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows, projected for the City by the TWQB are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.09	0.12	0.14	0.24
BOD in lb/day	160	212	259	456
TSS in lb/day	188	248	317	552

The existing wastewater collection system is illustrated on Plate CA-15. The collection system is more than adequate for present and future needs,

but extension of the collection lines needs to be made particularly to the area south of the Southern Pacific Railroad as well as to other locations of town where private disposal systems are now in operation. At present, only about 75 percent of the City is served. The system suffers from a moderate degree of infiltration during wet weather, but apparently it is being adequately handled without need of by-passing the treatment facilities.

The City's existing sewage treatment is located one-fourth mile west of Manor on Old Austin Road on the east bank of Gilleland Creek. The plant, constructed in 1956, has a design capacity of 0.053 mgd and serves approximately 500 persons through 175 sewer line connections. It is maintained in generally good condition and is of the Imhoff-tank type, consisting of an Imhoff tank, sludge drying beds and three oxidation ponds. Available sampling data published by the TWQB and the Texas State Department of Health is as follows:

Influent-Effluent Data

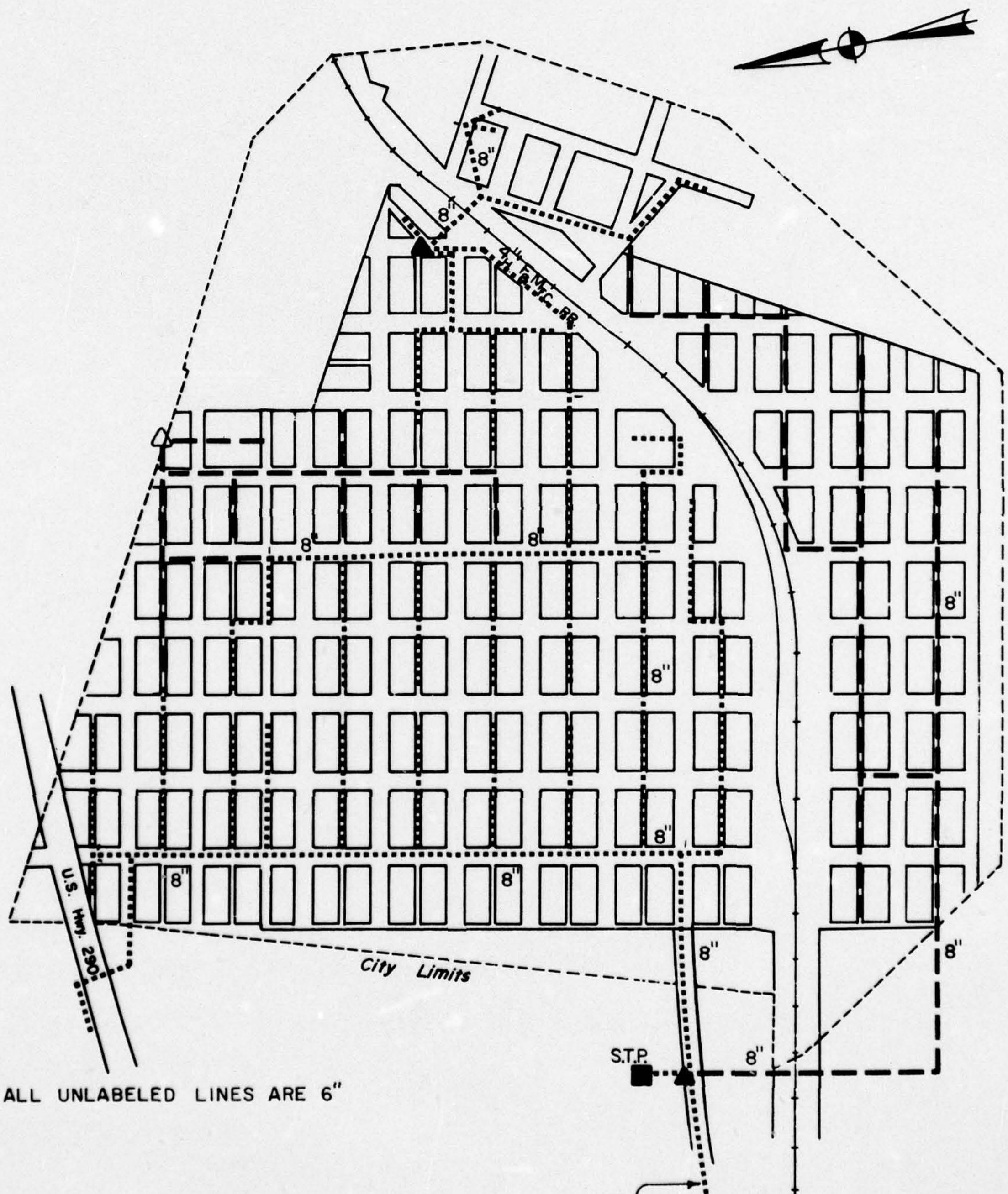
	TSDH (1972)	TWQB (1969)
Raw BOD (ppm)	150	160
Raw TSS (ppm)	120	142
Final BOD (ppm)	30	80
Final TSS (ppm)	47	102

Sludge disposal consists of its being spread around the plant site while effluent is discharged into Gilleland Creek.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best available technology economically achievable by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate treatment time.

The engineers for the City of Manor are presently preparing plans for expansions to the sewage collection system and sewage treatment facilities; however, these plans were not available at the time this report was prepared. The Highland Lakes Report, Phase III presented proposed collection system expansions to the City's system to provide service to a large septic tank area south of the H&TC Railroad as well as expanded service to a portion of the northern part of the City. These proposed collection system expansions are shown on Plate CA-15 and are recommended to be constructed by 1975.

The cost of the proposed collection system improvements, including 9,860 feet of 6-inch line, 4,080 feet of 8-inch line, a lift station and engineering



NOTE: ALL UNLABELED LINES ARE 6"

LEGEND

- EXISTING SEWER LINES
- PROPOSED SEWER LINES
- EXISTING LIFT STATIONS
- PROPOSED LIFT STATIONS

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MANOR, TEXAS

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and contingencies is estimated to be $154,700. It should be noted that most of the lines proposed are six inches in diameter whereas a larger portion of the system would consist of eight-inch diameter lines to meet the standards of this report.

In the Austin metropolitan area plan, it is proposed that by 1980 an interceptor be constructed from the Walnut Creek sewage treatment plant to the City of Manor sewage treatment plant to allow its abandonment at that time. Since any expansion proposed for the Manor sewage treatment plant would only serve from about 1975 to 1980 under this plan, it is recommended that an alternate method of disposal be considered.

The projected population for 1980 is 1,180. Assuming the overland runoff method of land disposal, a tract of approximately 16.5 acres would be required to renovate the wastewater from this population using an application rate of two inches per week. It is recommended that by 1975 the City enter into a leasing contract with an individual for the land disposal tract rather than purchase the land for this short period of time. This interim method of sewage treatment would serve until such time as the City of Austin constructs the proposed interceptor to Manor. It is also recommended that the three existing oxidation ponds be utilized as holding facilities prior to irrigation and that no discharge be allowed from the ponds into Gilleland Creek, which presently receives the effluent from the plant. This proposed wastewater treatment scheme would serve from 1975 to 1980 and the cost for the proposed improvements, including a sprinkler system, effluent pump and distribution line, is estimated to be $29,140, including engineering land contingencies.

By 1980 it is proposed to abandon the treatment facilities and convert the plant site to a lift station site. It is assumed that the City of Manor will be responsible for the costs of this lift station. The City may also be required to share in a portion of the cost of the interceptor to the Walnut Creek plant, however, this is beyond the scope of this report at the present time. The first increment of lift station capacity cost is estimated to be $37,200, including engineering and contingencies.

By 1990 an expansion of the lift station at the previous plant site will be required. The estimated cost for this expansion is $25,000, including engineering and contingencies.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Manor wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $121,600, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic

nitrogen reduction facilities at an approximate capital cost of $97,300, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $77,000, including engineering and contingencies.

Oak Hill.

The community of Oak Hill is located approximately two miles west of Austin on U.S. 290, and is under the jurisdiction of the CAPCO.

Population projections for the community as furnished by the TWDB are presented below.

Population Projections

Year	1970	1980	1990	2020
Population	425	560	690	1,490

Water is supplied to Oak Hill by Travis County WCID No. 9, which obtains treated water from the City of Austin.

The community is presently served by septic tanks. The Austin metropolitan plan proposes an interceptor sewer extension along Williamson Creek (Line CC-1) which will serve the Oak Hill area. This interceptor is proposed for construction by 1980.

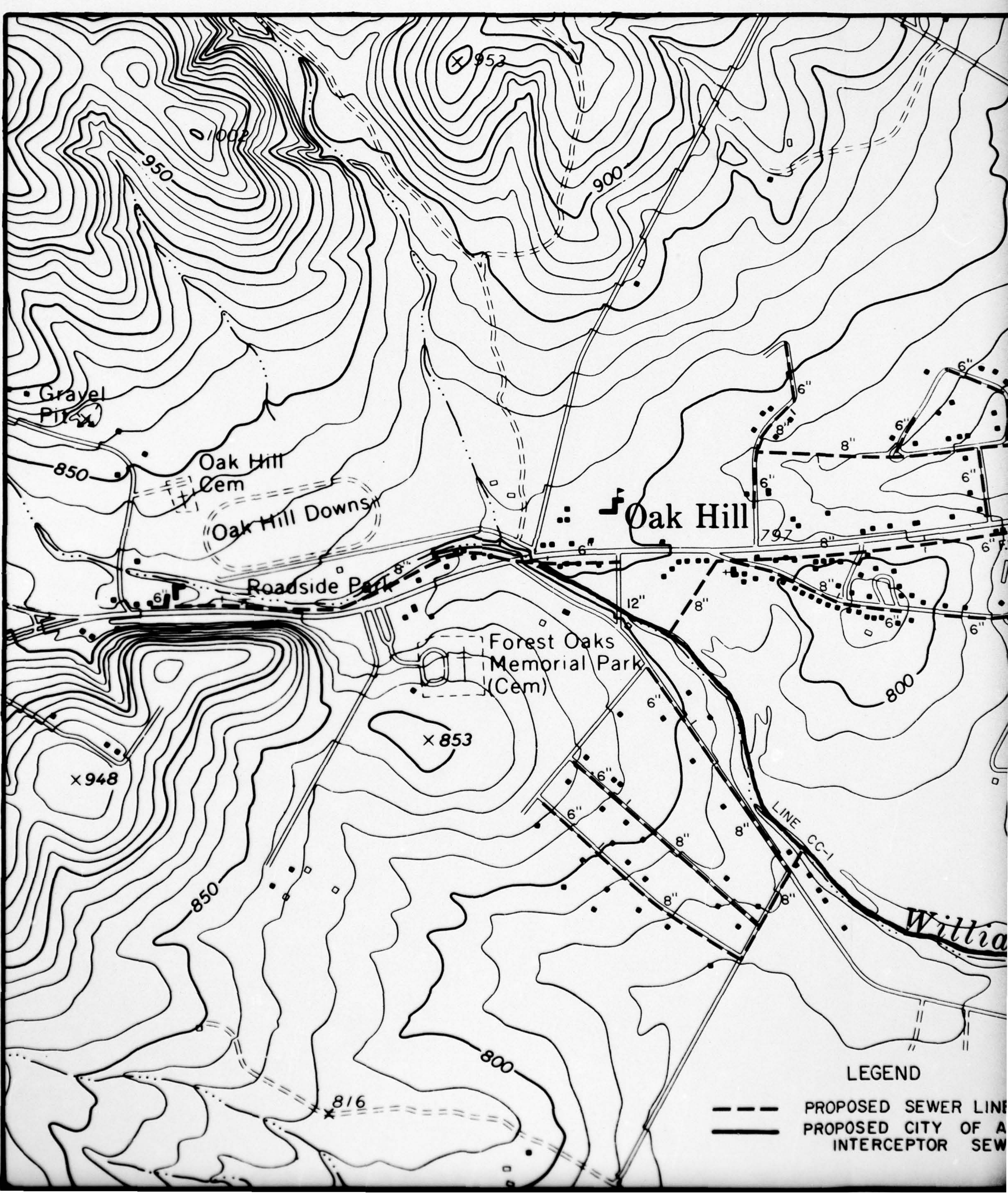
It is recommended that the Oak Hill community construct the proposed sewage collection system as shown on Plate CA-16 by 1980. Since sewage will be treated at the proposed Onion Creek sewage treatment plant, a contractual agreement between Oak HIll and Austin will have to be made for this service.

The estimated cost of the proposed collection system, including 6,600 feet of 6-inch line, 13,600 feet of 8-inch line, 2,000 feet of 6-inch force main, a lift station and engineering and contingencies, is $256,200.

It is therefore recommended that all steps necessary to implement the aforementioned interim no-discharge plan be undertaken. However, should the community of Oak Hill wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $95,200, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic


953
1002
950
900
Gravel Pit
850
Oak Hill Cem
Oak Hill Downs
Oak Hill
797
Roadside Park
Forest Oaks Memorial Park (Cem)
12"
8"
6"
800
853
948
LINE CC-1
Willia
850
800
816
LEGEND
PROPOSED SEWER LINE
PROPOSED CITY OF A
INTERCEPTOR SEW

AD-A036 850 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2
WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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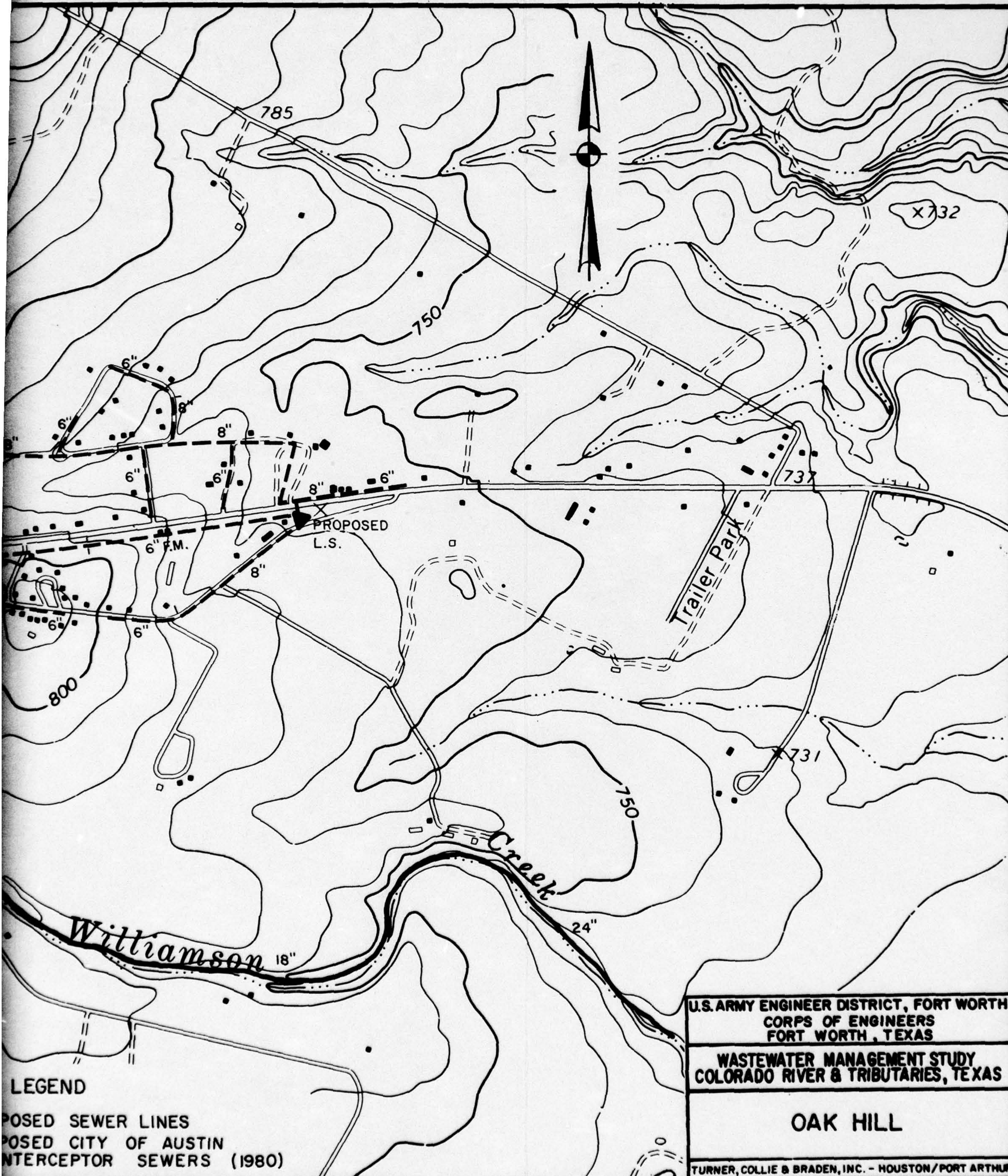


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

OAK HILL

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'   PLATE CA-16

nitrogen reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.

Pflugerville.

The City of Pflugerville is a general law municipality located approximately five miles northeast of Austin, Texas, in Tavis County. The City is under the jurisdiction of the CAPCO.

Population projections for Pflugerville supplied by the TWDB are presented below.

Population Projections

Year	1970	1980	1990	2020
Population	549	730	890	1,370

Water is supplied to the City by a private water system using wells as the source. Two wells approximately 700 feet deep with a combined capacity of 150 gallons per minute serve the distribution system which has approximately 193 water connections. The distribution system also has a 50,000 gallon capacity elevated storage tank.

The City is predominately underlain by soils of the Austin-Houston Black association. These soils are dark grayish brown to grayish brown friable calcareous silty clay to clay surface, 10 to 25 inches thick, over brown to pale brown, friable, strongly granular, highly calcareous silty clay to clay. Chalky marl or chalk is encountered at depths of 15 to 30 inches with the Austin soils, while strongly calcareous mottled yellow and gray clay at depths of 30 to 60 inches is associated with the Houston Black soils. The Austin soils are gently sloping to moderately rolling (1 to 10 percent slopes) while the Houston Black soils are nearly level to gently sloping (1 to 4 percent slopes). The permeability of the Austin soils ranges from 0.2 to 0.63 inch per hour, while the Houston Black soils have permeabilities of less than 0.06 inch per hour.

The City does not have a collection system and septic tanks are used for disposal of sewage. Under the Austin metropolitan plan, an interceptor (Line A-2-b) is proposed for construction by 1990 to serve Pflugerville and adjacent areas. It is recommended that the City construct the proposed collection system shown on Plate CA-17 by 1975. The cost of these proposed collection system improvements, including lift stations, 13,200 feet of 6-inch line, 15,800 feet of 8-inch line and engineering and contingencies, is estimated to be $475,900. It is also recommended that the City of Pflugerville construct a secondary wastewater treatment facility

having a design capacity of 0.09 mgd by 1975. Assuming the overland run-off method of land disposal with an application rate of two inches per week, the required amount of land required to further treat the secondary effluent from the 1990 projected population is 12.5 acres. Therefore it is also recommended that, by 1983, the City acquire at least 12.5 acres of land for the overland runoff system. An effluent holding pond will also be required by 1983, prior to land alpplication of the effluent. It is recommended that a pond with a capacity to hold seven days average sewage flow for 1990 conditions be constructed (0.09 mgd x 7 days = 0.63 mg). If the depth of the pond is assumed to be four feet, the surface area required would be 0.5 acre.

Since the land disposal site is proposed on an interim basis or until 1990, it is recommended that the City enter into a contractual agreement with an individual for the tract rather than purchasing land. The estimated cost of the proposed secondary treatment facility is $109,620, including engineering and contingencies. The secondary treatment facility would serve from 1975 to 1990.

The estimated cost for the 1983 land disposal improvements, including an effluent holding pond, sprinkler system, effluent pump, distribution line and engineering and contingencies, is $32,990. It should be noted that no costs are included for the cost of sewage treatment upon abandonment of the proposed sewage treatment facilities in 1990. This cost will have to result from an agreement between Pflugerville and the City of Austin for sewage treatment service.

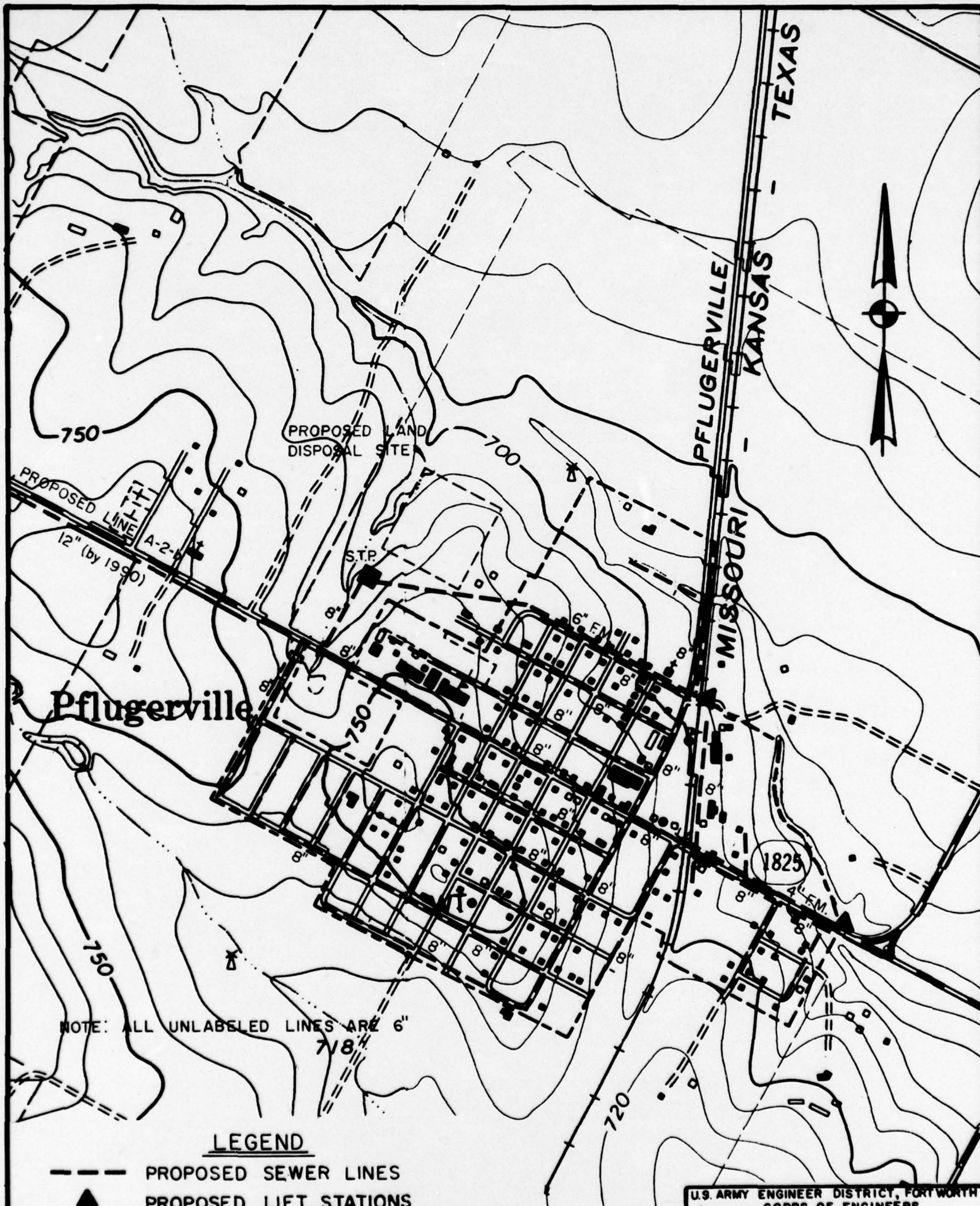
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best available technology economically achievable by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when disposal is executed in an approved manner and when no effluent is introduced directly into surface or ground water resources either by runoff or percolation without adequate treatment time.

It is therefore recommended that all steps necessary to implement the aforementioned interim no-discharge plan be undertaken. However, should the City of Pflugerville wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $109,620, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $92,800, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction


MISSOURI - KANSAS - TEXAS
PFLUGERVILLE
750
700
720
718
PROPOSED LAND DISPOSAL SITE
PROPOSED LINE A-2-b
12" (by 1990)
S.T.P.
6" F.M.
4" F.M.
8"
1825
Pflugerville
NOTE: ALL UNLABELED LINES ARE 6"
LEGEND
PROPOSED SEWER LINES
PROPOSED LIFT STATIONS
PROPOSED SEWAGE TREATMENT PLANT
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
PFLUGERVILLE, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE: CA-17

facilities at an approximate capital cost of $85,500, including engineering and contingencies.

Rollingwood.

The City of Rollingwood is a general law municipality located south of Town Lake in the southwest part of Austin. It is bounded by the City of West Lake Hills on the west, the City of Austin on the north and east, and Bee Cave Road on the south. Rollingwood is under the jurisdiction of the CAPCO.

Population projections for Rollingwood as supplied by the TWDB are presented below.

Population Projections

Year	1970	1980	1990	2020
Population	780	1,010	1,240	2,060

Water is supplied to the City by the Austin water distribution system. The City does not have a collection system, but depends on individual septic tanks for wastewater disposal. These septic tanks are also considered to be a potential source of pollution to Town Lake, as is the case for the City of West Lake Hills.

The City of Rollingwood is proposed to be served by an interceptor sewer proposed by 1980 under the Austin metropolitan section (Line BB-2 and Line BB-2-a) which will also provide sewer service to a portion of West Lake Hills.

It is recommended that the City of Rollingwood construct the sewage collection system as shown on Plate CA-19 by 1980. Sewage will be treated at the Austin Govalle plant, therefore, a contractual agreement between Rollingwood and Austin will have to be made for this service.

The estimated cost of the proposed collection system, including 12,600 feet of 6-inch line, 17,500 feet of 8-inch line and engineering and contingencies, is approximately $437,000.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Rollingwood wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $121,600, including engineering and contingencies.
2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $96,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $92,500, including engineering and contingencies.

Sunset Valley.

The City of Sunset Valley is a general law municipality located west of the intersection of U.S. 290 with Ben White Blvd. (Loop 360) just southwest of the City of Austin. The City is under the jurisdiction of the CAPCO.

Population projections for the City as supplied by the TWDB are presented below.

Population Projections

Year	1970	1980	1990	2020
Population	292	390	480	800

Water supply for the City consists of wells. Approximately one-half of the residents are served by a private water supply system, with the remainder using individual wells.

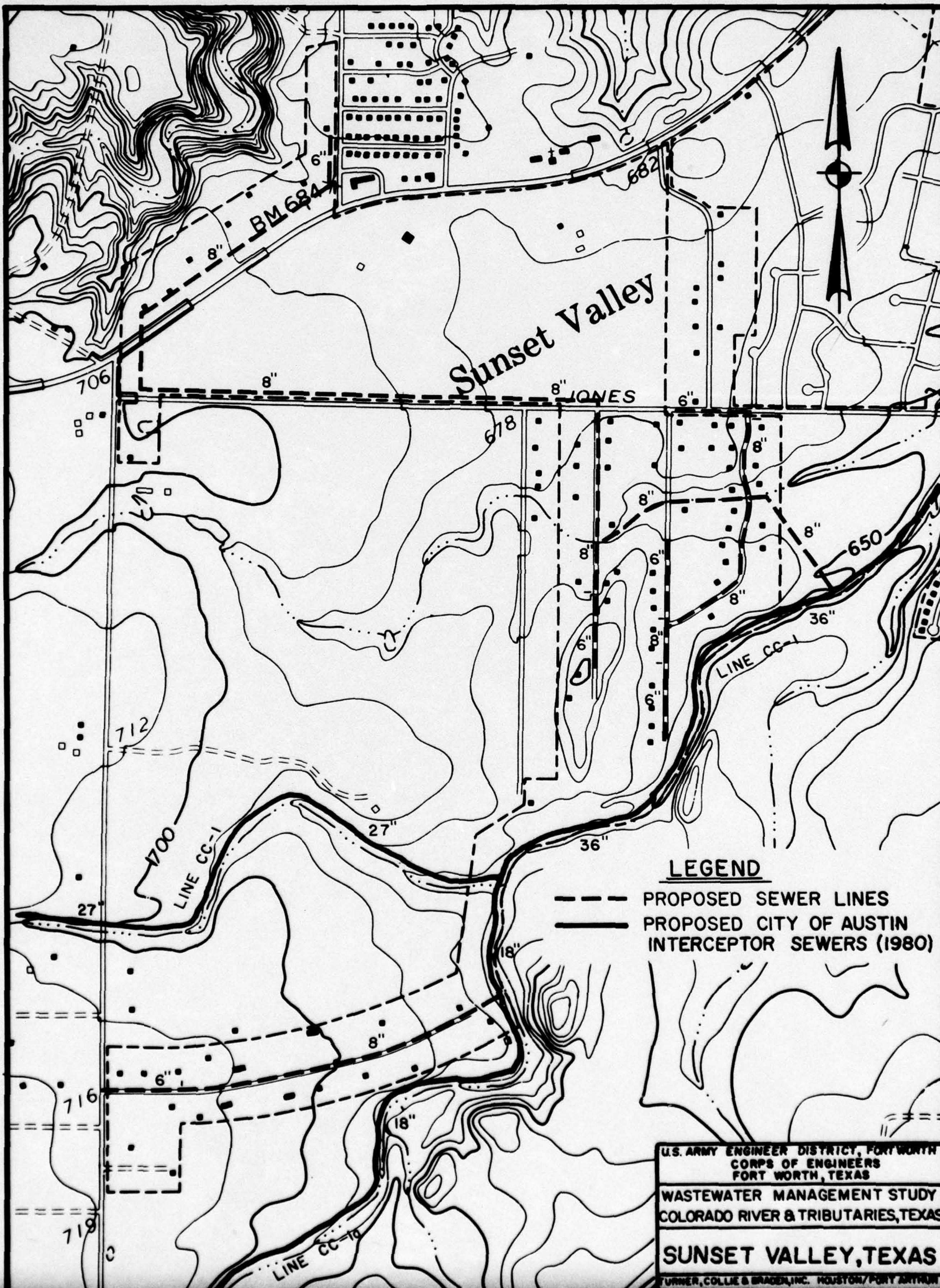
The area is presently served by septic tanks. It is proposed that the Sunset Valley area be served by the interceptor proposed to extend up Williamson Creek (Line CC-1) under the Austin metropolitan plan. Since the interceptor is proposed for construction by 1980, it is recommended that the City of Sunset Valley construct the proposed collection system as shown on Plate CA-18 by 1980. Since sewage will be treated by the proposed Onion Creek sewage treatment plant, a contractual agreement between Sunset Valley and Austin will have to be made for this service.

The estimated cost of the proposed collection system, including 3,000 feet of 6-inch line, 14,800 feet of 8-inch line and engineering and contingencies is approximately $198,600.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Sunset Valley wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $68,710, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,300, including engineering and contingencies.


Sunset Valley
BM 684
682
706
JONES
678
650
712
700
716
719
LINE CC-I
LINE CC-I
LINE CC-10
LEGEND
PROPOSED SEWER LINES
PROPOSED CITY OF AUSTIN INTERCEPTOR SEWERS (1980)
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SUNSET VALLEY, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $71,000, including engineering and contingencies.

West Lake Hills.

The City of West Lake Hills is an incorporated general law municipality located west of Austin and north of Bee Cave Road (F.M. 2244). Although the corporate limits include a large area of land, most of the residences are located between Bee Cave Road and Red Bud Trail, and along the west side of Lake Austin as shown on Plate CA-19. The City is under the jurisdiction of the CAPCO.

Population projections for West Lake Hills, as supplied by the TWDB, are presented below.

Population Projections

Year	1970	1980	1990	2020
Population	1,488	1,910	2,340	3,890

Water is supplied to the City by Travis County WCID No. 10, which obtains treated water from the City of Austin. The area is presently served by septic tanks, which are considered to be a potential source of pollution to Town Lake as reported in the Highland Lakes Report.

The West Lake Hills area is proposed to be served by the interceptor sewer system proposed under the Austin metropolitan area collection systems as shown on Plate CA-19. The northern portion of the West Lake Hills area will be served by Line AA-2 which is tributary to the Crosstown Interceptor Tunnel and the Walnut Creek sewage treatment plant. The remainder of the West Lake Hills area will be served by Line BB, Line BB-2, and Line BB-2-a which are tributary to the Govalle sewage treatment plant. These proposed interceptor sewers are recommended for construction by 1980.

Additional main sewers and laterals will also need to be constructed to provide sewer service to West Lake Hills. It is recommended that the proposed collection lines as shown on Plate CA-19, which are tributary to the above-mentioned interceptors, be constructed by 1980. The cost of these 1980 proposed collection system improvements, including 18,200 feet of 6-inch line, 69,800 feet of 8-inch line and engineering and contingencies, is estimated to be $1,379,300.

Since the sewage will be treated by one of the City of Austin plants, the cost of the sewage treatment will have to be agreed upon between Austin and West Lake Hills.

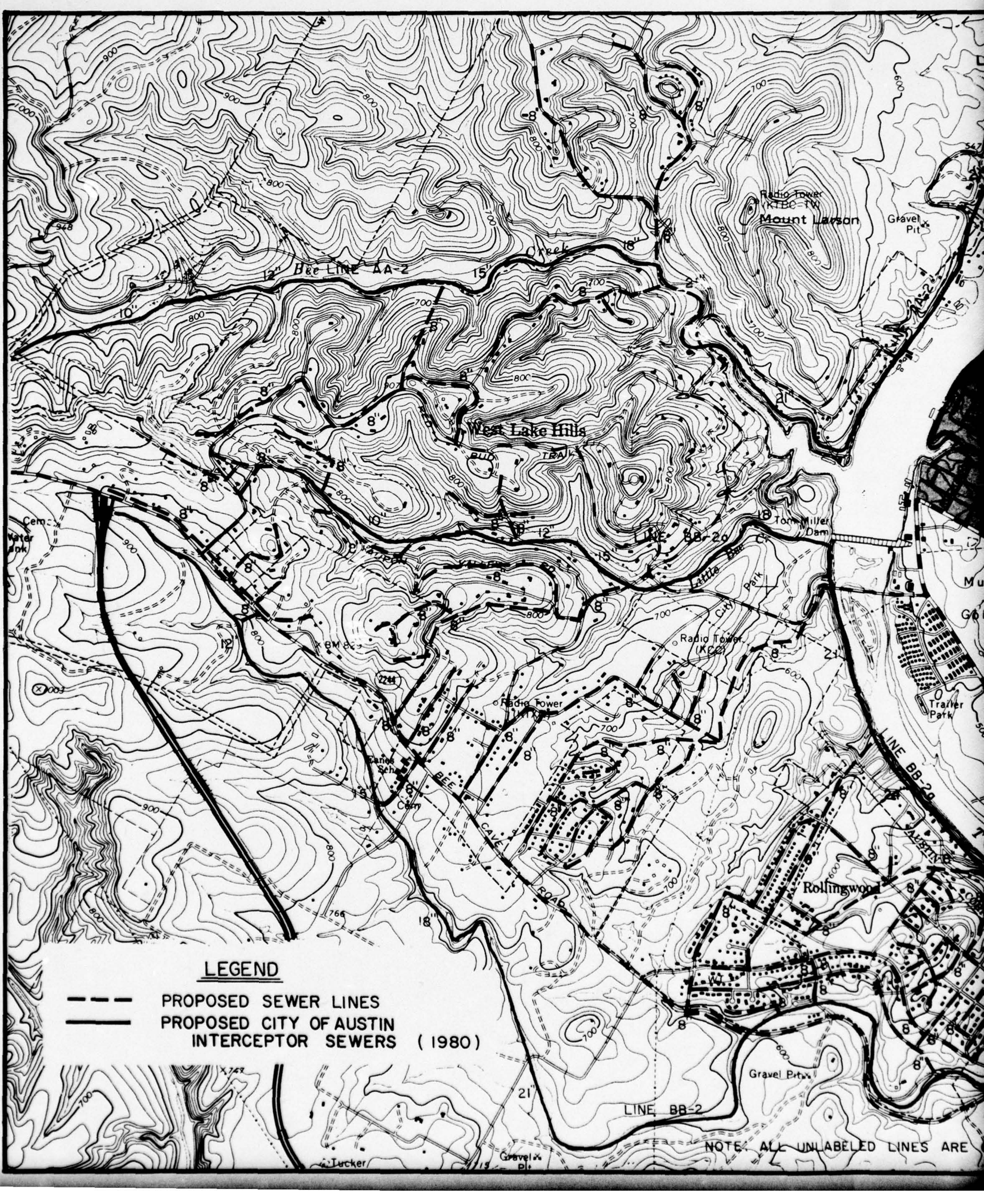
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the

City of West Lake Hills wish to implement a discharge plan, the following items would be required:

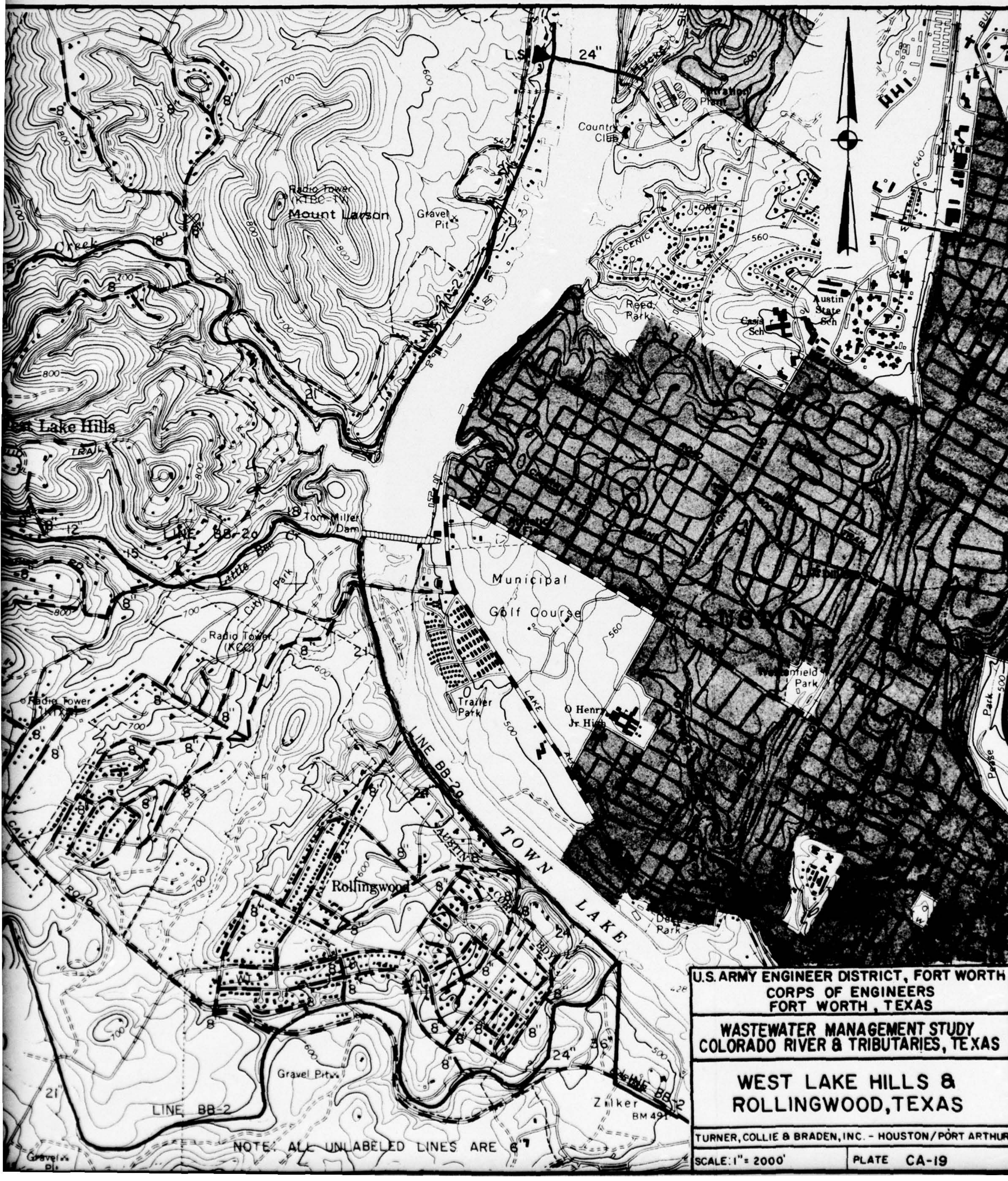
1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,100, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $128,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $88,000, including engineering and contingencies.



LEGEND
PROPOSED SEWER LINES
PROPOSED CITY OF AUSTIN
INTERCEPTOR SEWERS (1980)
West Lake Hills
Mount Larson
Rollingwood
Tom Miller Dam
Radio Tower (KCC)
Gravel Pit
Trailer Park
LINE AA-2
LINE BB-2a
LINE BB-2
Bee Creek
Little Bee Cr
City Park
Gravel Pits
NOTE: ALL UNLABELED LINES ARE



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

WEST LAKE HILLS & ROLLINGWOOD, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' PLATE CA-19

APPENDIX A

A RATIONALE FOR PHASED IMPLEMENTATION OF WASTEWATER TREATMENT PROCESSES

Introduction.

Technology and knowledge are presently available to design and construct wastewater treatment facilities capable of reclaiming an excellent quality water from wastewater. However, funding of such massive construction projects for the Nation, State, or river basin cannot be accomplished in one sweeping construction program. Therefore, it becomes necessary to devise a schedule for implementation of advanced wastewater treatment facilities that allows for phasing of construction and funding. Phasing allows available funds and future planning for funding to move at a feasible and rational pace.

The following advanced wastewater treatment facility implementation schedule has been devised for the purpose of this study. The examples presented represent a biological treatment scheme since at the present time there are no other treatment methods utilized in the Basin. It should be recognized that these are presented only as examples and a detailed presentation of alternative treatment processes is presented elsewhere in the Technical Appendix, Volume III.

In cognizance of the PL 92-500 which state that publicly owned treatment works must provide "secondary" treatment of effluent by 1977 and the best practicable waste treatment technology by 1983 as a minimum of implementation, it was necessary to have a definition of these goals prior to preparation of all area-wide planning. To have awaited these definitions would have necessitated at least a six-month delay in the overall study effort. Therefore, the following rationale was utilized as a basis in establishing water quality goals in the Basin.

Secondary Treatment.

It was assumed for the purpose of this study, the effluent criteria desired for 1977 would be that expected from a properly operating secondary wastewater treatment plant receiving domestic wastewater. The effluent would contain a total BOD_5 level of 20 mg/l and a total suspended solids (TSS) level of 20 mg/l. This effluent would be disinfected and contain a minimum dissolved oxygen (DO) of 5.0 mg/l.

A number of communities in the CAPCO region utilize the Imhoff tank-oxidation pond method of primary and secondary treatment. It is the prevailing opinion that the Imhoff tank does not provide adequate primary treatment. The solids accumulate on the walls of the settling chambers and require manual scraping to insure that all settled solids reach the digestion zone of the Imhoff tank. The digestion zone utilizes anaerobic conditions to break down the settled solids. The septic

conditions existing in the unit produce gas bubbles which rise and carry particles back into suspension. This action also floats scum and grease to the surface of the liquid in the tank where a scum layer forms. If this layer is not frequently broken up, it will harden trapping gasses trying to escape resulting in conditions of low pH unfavorable to anaerobic digestion of the bottom sludges.

Where wasteload projection data indicate the need to expand the treatment capacity of a system utilizing an Imhoff tank for primary treatment, it will be recommended that the Imhoff tank be abandoned as the primary treatment unit and replaced by a conventional clarifier and anaerobic sludge digester. The clarifier is assumed to be equipped with mechanical scum and sludge removal equipment which will provide a much greater efficiency for removal of solids and, thus, primary treatment. It is recommended that, upon construction of a clarifier to replace an Imhoff tank, the Imhoff tank be dewatered and inspected for potential salvage use such as chlorine contact, sludge thickening, or aerobic digestion.

Oxidation ponds vary in their efficiency for removal of BOD_5 and TSS due to seasonal and climatic conditions, nature and strength of the influent wastewater, and physical characteristics of the ponds. In the publication, "Waste Treatment Lagoons - State of the Art," Water Pollution Control Research Series, 17090 EHX 07/71, U.S.E.P.A., reservations are expressed as to the future of oxidation ponds. In order to examine oxidation ponds, an arbitrary failure scale was developed based on BOD_5 and suspended solids in the effluent. The first degree failure occurred when BOD_5 exceeded 20 mg/l and suspended solids exceeded 25 mg/l. A second degree failure occurred when BOD_5 exceeded 30 mg/l and suspended solids exceeded 40 mg/l, and third degree failure occurred when BOD_5 exceeded 40 mg/l and suspended solids exceeded 45 mg/l. Examination of published data on oxidation pond operation indicated that of 20 ponds studied, 16 ponds exceeded third degree failure for BOD_5 and the remaining ponds exceeded second degree failure. With regard to suspended solids data, 15 plants were studied, and all showed third degree failures. This observation is substantiated by reviewing the effluent sampling data supplied by the TWQB and Texas State Department of Health, which show BOD_5 in the effluent ranging from 20 mg/l to 75 mg/l.

Based on the above discussion, oxidation ponds will not be considered as adequate secondary treatment in this report where the effluent is discharged into a receiving stream or surface water body. Oxidation ponds will be considered adequate however, when they are followed by land disposal of the effluent, which is practiced by a number of the communities utilizing oxidation ponds for secondary treatment. It is also recommended in this report that oxidation ponds be utilized as holding ponds following conventional secondary treatment preceding land disposal of the effluent.

Best Practicable Treatment.

It was further assumed that best practicable treatment by 1983 would be to reduce the BOD_5 and TSS to at least a level of 12 mg/l and 9 mg/l respectively. These levels can be achieved by several methods, but most practically by installation of filtration equipment. This equipment can be utilized to filter a portion of the total flow at a low filtration rate, and then the filtered portion and unfiltered portion could be blended at the proportions required to meet the BOD_5 and TSS level in the final effluent. Based on the literature and process review accomplished for this study and presented elsewhere in the Technical Appendix, it was conservatively assumed that filtration would reduce BOD_5 and TSS constitutent levels 60 and 80 percent respectively. Subsequent calculations indicated that the filtered portion would have to be two-thirds of the total flow to meet the 12/9 mg/l objective. Total filtration would be expected to reduce these constituent levels to 8 mg/l and 4 mg/l respectively, and may be required in some sensitive receiving water quality areas. Another approach, utilizing the same capital outlay, would be to operate the filtration units at high loadings (8 to 10 gpm/sq. ft.) and filter all effluent from the secondary process. The units would, however, require more operation and maintenance, and the method was not given further consideration. In addition to reducing the BOD_5 level, equipment should be installed to reduce the phosphorus concentration, as well as the ammonia-nitrogen and organic nitrogen levels. It is felt that the following processes may produce some associated further reduction of BOD_5 and TSS constituent levels; however, insufficient data exists to make a justifiable prediction of what the BOD_5 and TSS levels would be.

Phosphorus is one of the two principal nutrients that can attribute to excess algae and/or aquatic weed growth. Excess algae and/or aquatic weeds can create noxious tastes and odors in drinking water and are aesthetically displeasing in surface water. Therefore, any first stage advanced treatment should address itself to limiting the availability of this principal nutrient.

Phosphorus, measured as "P", can be reduced to 2 to 3 mg/l by two stage addition of iron and/or aluminum salts. The first addition should be near the head of the treatment facility with the second addition prior to filtration. This would generate approximately 80 percent reduction in the phosphorus discharged to receiving waters.

Reduction of the ammonia and organic nitrogen levels is desirable to eliminate the oxygen depletion downstream of the discharge point. The nitrogeneous oxygen requirement is significant and should be eliminated at the treatment facility.

Ninety to 95 percent of the ammonia an organic nitrogen can be converted to nitrite and nitrate nitrogen in a suspended biological floc system. This conversion is not, however, expected to affect any reduction in the total nitrogen level. It is possible for the bacteria responsible for the conversion,

nitrosomonas and nitrobacters, to be cultivated in an activated sludge plant under optimum conditions. These conditions are DO of the aeration basin equal to or greater than 2.0 mg/l, a sludge age of at least four days, pH range 7.8 to 8.0, and low heavy metals concentration. Many existing treatment facilities can be modified to produce these conditions; however, others will require the construction of additional aeration and clarification systems.

Summarizing the anticipated effluent characteristics assumed for the 1983 best practicable treatment level for domestic wastewater treatment facilities, it is expected that the effluent would have BOD_5 and TSS concentration of 12 mg/l and 9 m/gl respectively, phosphorus (as "P") of 2 to 3 mg/l, and an ammonia and organic nitrogen level of 1 to 2 mg/l, with adequate disinfection and DO of 5.0 mg/l.

Best Treatment Feasible.

It was further assumed that "no-discharge of pollutants" treatment by 1985 would be the best treatment feasible. The final phase of treatment, processes to effect best treatment feasible to be implemented, is expected to require denitrification and additional solids reduction. The increased solids removal can be accomplished by additional filtration capacity. Utilizing total filtration, the BOD_5 and TSS solids levels would be expected to be reduced to 8 mg/l and 4 mg/l respectively.[1] This increased filtration will also decrease the colloidal phosphorus compounds generated by the metallic salts addition, although a coagulant aid will probably be required prior to filtration to decrease the phosphorus in the effluent to 0.2 mg/l.

Denitrification may be accomplished by an anaerobic biological process, preferably preceding the filtration units. The nitrification process previously implemented in the 1983 phase, converted the ammonia and organic nitrogen to nitrite and nitrate nitrogen. The denitrification step breaks oxygen from the nitrite and nitrate and nitrogen gas is released. This process, when coupled with nitrification is expected to reduce the nitrogen level approximately 85 percent, and can reduce the total nitrogen level to 2 mg/l.

Summarizing the anticipated effluent quality for reasonable, most feasible treatment for domestic wastewater, it is expected that a BOD_5 of 8 mg/l, TSS of 4 mg/l, phosphorus measured at "P" of 0.2 mg/l, total nitrogen of 2.0 mg/l, fecal coliform equal to or less than MPN of 200 per 100 ml and a DO of 5 mg/l will be present. The remaining organic load could be reduced further by absorption on activated carbon if necessary, however, the process was not considered justifiable for a generalized treatment scheme at the at the present time considering the associated costs and the capabilities of most municipalities.

1 It should be noted that the literature indicates total filtration may attain a 5 mg/l BOD_5 level for some wastewaters.

The Highland Lakes.

In discusssing phased implementation of wastewater treatment processes, the Highland Lakes must be reviewed as a special case. All recent TWQB permits issued for facilities along the lakes require no-discharge conditions. At present, teritary treatment is in operation along the lakes generally consisting of golf course irrigation with treated secondary effluent by the overland runoff method of land disposal. Because the Highland Lakes are used for direct contact recreation and also as a source of municipal drinking water, it appears that higher effluent standards for some constituents may be developed exclusively for the lakes, sooner than would be indicated by the general rationale interpreting PL 92-500.

Therefore, it was assumed for this report that all proposed and existing treatment plants adjacent to the Highland Lakes would meet, as a minimum, effluent standards of at least 8/4 for BOD/TSS by 1975. As mentioned previously, this level of treatment can be obtained by total filtration of secondary effluent as defined for this study.

In other non-metropolitan areas through out the Basin, it has been proposed to utilize irrigation or land disposal of effluent prior to 1983 to be in compliance with PL 92-500 discussed previously. Land disposal of effluent has been reported to satisfy the requirements defining "best treatment feasible" when executed in an approved manner. Unfortunately, the soils surrounding the Highland Lakes are generally not suitable for any of the three methods of land disposal considered in this report without extensive site work. The main restrictions with respect to potential land disposal sites are unsatisfactory permeabilities, absence of soil covering in some areas, and surface slopes which do not meet the minimum and maximum standards set forth in this report. As mentioned previously, there are developments along the lakes which utilize secondary effluent for irrigation of golf courses by the overland runoff method, but these areas were designed and constructed which meet the requirements to allow irrigation by sprinkler-type application equipment.

For the above reasons, initial tertiary treatment proposed for the developed areas adjacent to the lakes includes total filtration of secondary effluent instead of partial filtration as described in the general rationale. It is mentioned in the introductory discussion for each of the Highland Lakes; however, if an area constructs secondary treatment facilities and there is a tract of land available on a permanent basis which meets the requirements for one of the land disposal methods, this type of effluent disposal may be substituted for any of the other methods of tertiary treatment proposed in this report.

In addition to current restrictions on BOD_5 and TSS effluent constituent levels, the TWQB is presently considering nutrient removal requirements for the Highland Lakes that may or may not be consistent with the rationale utilized for this report. The final decision on nutrient removal will be a result of studies in progress at the time this report was prepared. It will be assumed for the purpose of this report that nutrient removal

comparable to the levels indicated to meet the best treatment feasible, objectives of the general rationale will be required by 1983 for the Highland Lakes area. First incremental implementation costs for these removals are presented in the discussions for each of the areas adjacent to the Highland Lakes.

It must be pointed out, however, that the likelihood exists that the results of the ongoing studies could indicate the lakes are nutrient deficient rather than nutrient enriched. It would, therefore, fall that the lakes would be enhanced by the discharge of effluent from conventional secondary facilities and that no nutrient removal would be recommended. Further conjecture in this area must be left to others.

AREAWIDE PLAN
FOR
HOUSTON-GALVESTON AREA COUNCIL

Introduction.

The purpose of this section of the Colorado River Basin Wastewater Management Study is to present the areawide plan for the area within the boundaries of the Houston-Galveston Area Council (H-GAC) within the Colorado River Basin. The formost objective of the areawide plans presented in this section is to recommend the best plan which will satisfy the requirements of PL 92-500 and the waste load allocations as set forth for the Colorado River Basin for each community presently having or in need of a municipal wastewater treatment system.

Planning Authority.

The planning coordination agency for this study area is the H-GAC, with offices in Houston. The Executive Committee is designated as the governing body of the Council. The Executive Committee is responsible for general policies, programs, and control of Council funds. The General Assembly elects officers and approves the annual budget. There are several implementing agencies whose realm lies within the study area. These include: Colorado Sewer and Water Control District, Matagorda Sewer and Water Control District, and Wharton Sewer and Water Control District.

Physical Description of Planning Area.

Study Area Delineation.

The H-GAC is located in southeast Texas; however, only a portion of the Council lies within the Colorado study area. As shown on Plate HG-A, this portion includes approximately half of Colorado County, about one-third of Wharton County, and a small part of Matagorda County. The remainder of this discussion will be confined to this area.

Climate Description.

The mean annual temperature for the study area varies from 69° in Colorado County to 71° in Matagorda County. The average low temperature is in the 40's in January, while in the summer the average high is in the 90's. The growing season averages approximately 260 days. Annual rainfall in the study area is about 40 inches. The mean annual net evaporation rate is 20 inches. During the drought period which occurred from 1950 to 1956, the mean annual evaporation increased to 30 inches. During the summer months the prevailing wind is from the south and southeast. During the winter there is no prevalent wind direction. The mean annual relative humidity varies from 85 percent at 6 a.m. to 65 percent at 6 p.m.

Hydrology.

The study area lies in the Gulf Coastal Plain. The northern portion of the study area is rolling, but the topography becomes increasingly level towards the Gulf of Mexico. The area is drained primarily by the Colorado River and direct runoff to the Gulf of Mexico. There are no major reservoirs in the study area which regulate flow; however, the Colubmus Bend Reservoir has been porposed in Colorado County.

Water Resources.

The study area contains one primary freshwater aquifer, the Gulf Coast Sands, which serves the entire area. At present, the only surface water reservoir is Eagle Lake in Colorado County. As stated previously, the Columbus Bend Reservoir has been proposed for the area. Present and projected water use for the area is shown in Tables HG-1 and HG-2.

Geology.

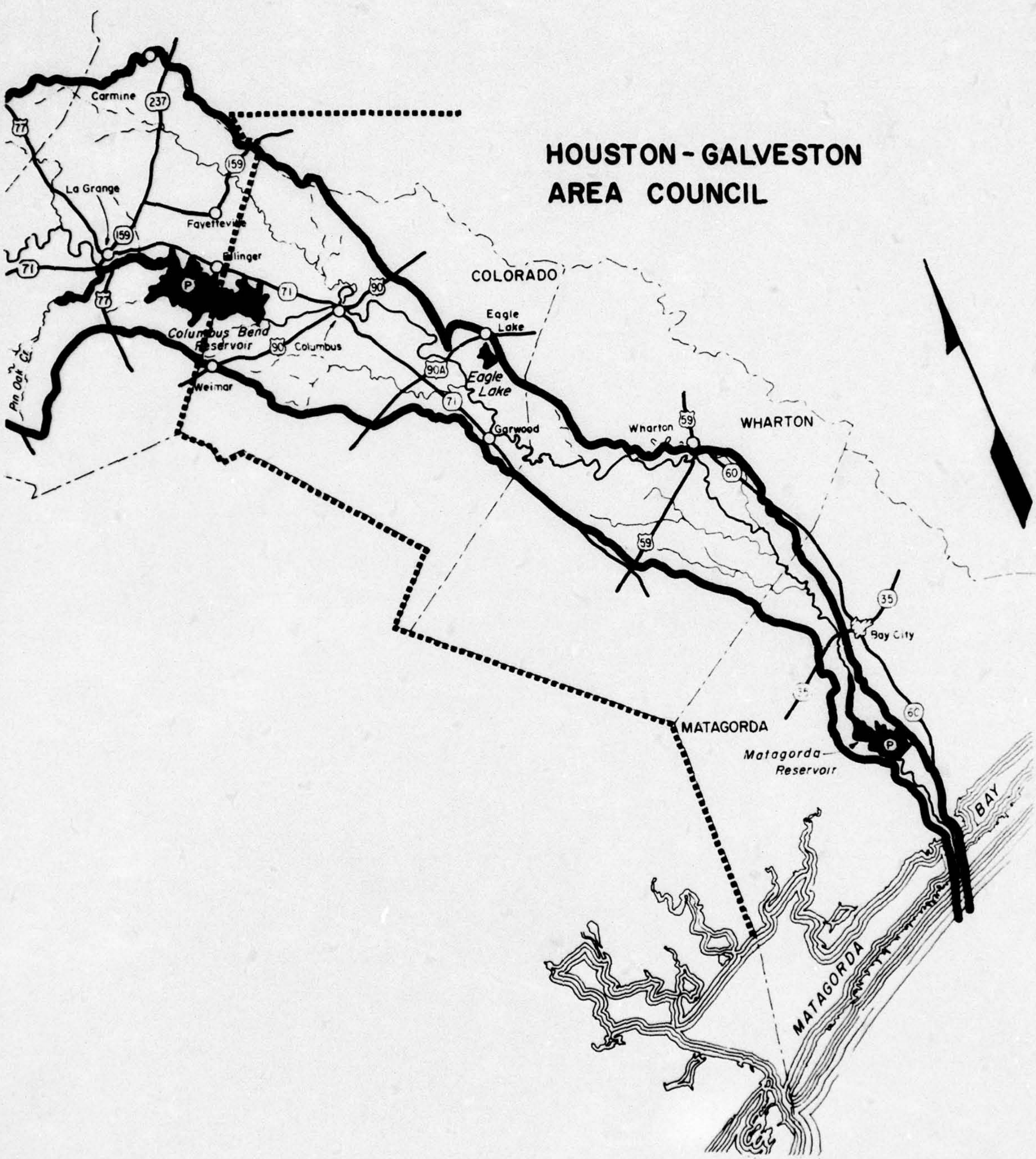
The surface geology of the area consists of several geologic ages. All of Matagorda and Wharton Counties and the southern portion of Colorado County are of the Quaternary age. The remainder of Colorado County is of the Pliocene, Miocene, and Oligocene ages. The study area contains two general land resource areas. Matagorda and Wharton Counties, and the southern portion of Colorado County are in the Coastal Prairie. The remainder of Colorado County lies in the East Texas Timberlands. The soils of the Coastal Prairie are generally reddish brown to dark gray, calcareous clay loams and clays. Those of the East Texas Timberlands are light brown to dark gray, acid, sandy loams, clay loams, and some clays.

Natural vegetation in Colorado County consists generally of hickory, post oak, and blackjack oak. That of Wharton and Matagorda Counties consists of marsh and salt grasses, coarse and coarse bunch grasses.

Social and Economic Description of Planning Area.

Population.

Table HG-3 gives existing and projected populations for the portions of each county within the study area. The existing and projected urban population is also included in the table, with urban population consisting of those communities with a population of 2,500 or greater. For this area, the urban population consists of the populace of Columbus, Eagle Lake, El Campo, and Wharton. Only portions of El Campo and Wharton lie within the study area. The figures given include only the portions within the study area. The urban population is expected to increase slightly while the rural population is expected to decrease; however, the overall population is not expected to show much change.



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

HGAC STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 16 MI. PLATE HG-A

TABLE HG-1

WATER REQUIREMENTS*

County	Requirement	1970	1980	1990	2020
Colorado	Municipal	1,660	1,822	1,941	2,079
	Industrial	1,744	2,077	2,352	3,415
Matagorda	Municipal	176	205	230	457
	Industrial	6,717	11,587	14,905	31,648
Wharton	Municipal	899	957	1,008	1,095
	Industrial	67	83	93	128
TOTAL	Municipal	2,735	2,984	3,179	3,631
	Industrial	8,528	13,747	17,350	35,227
	Total	11,263	16,731	20,529	38,858

***Acre-feet per year.**

TABLE HG-2

IRRIGATION WATER REQUIREMENTS*

	SURFACE				GROUND			
County	1970	1980	1990	2020	1970	1980	1990	2020
Colorado	7,584	8,794	9,896	14,924	13,868	12,798	11,818	6,460
Matagorda	22,200	27,703	32,708	33,110	321	0	0	0
Wharton	11,690	17,122	22,057	53,976	18,629	18,970	19,282	10,540
TOTAL	41,474	53,619	64,661	102,010	32,818	31,768	31,100	17,000

***Acre-feet per year.**

TABLE HG-3

POPULATION PROJECTIONS

County		1970	1980	1990	2020
Colorado	Urban	6,929	7,340	7,630	7,890
	Rural	4,703	4,250	4,020	3,000
	Total	11,632	11,590	11,650	10,890
Matagorda	Urban	–	–	–	–
	Rural	1,657	1,710	1,890	2,390
	Total	1,657	1,710	1,890	2,390
Wharton	Urban	2,501	2,710	2,720	2,590
	Rural	4,047	3,790	3,850	3,730
	Total	6,548	6,500	6,570	6,320
TOTAL	Urban	9,430	10,050	10,350	10,480
	Rural	10,407	9,750	9,760	9,120
	Total	19,837	19,800	20,110	19,600

Land Use Analysis.

Much of the land in this study area is agricultural, ranch, and generally open, undeveloped land. Agricultural and ranch land is used for the production of rice, cotton, and cattle. A small amount of the land in the study area is used for residential, commercial, and industrial purposes.

Economic Analysis.

The major economic base for this study area consists of the agricultural and oil industries. Rice, cattle, and oil dominate the economy. As evidenced by the relatively stable overall population projection for the region, the study area is not expected to experience significant economic growth in the future.

Existing Waste Loads.

Within each area plan which follows, the projected waste loadings as furnished by the TWQB are presented. Those projections were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in Volume II, Basin Plan Appendix.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream. These data are summarized in Table HG-4.

Very little of the available sampling data was consistent; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in many of the loadings and estimates.

Columbus, Texas.

The City of Columbus is an incorporated, general law municipality located in the north central part of Colorado County at the intersection of I.H. 10 and S.H. 71 approximately 70 miles west of Houston, Texas. The incorporated area of the City encompasses about 1,000 acres. Columbus is the county seat of Colorado County and is located within the jurisdiction of the H-GAC.

The City has little topographical relief and is drained primarily by direct runoff to the Colorado River. The central, southern, and eastern section of the City drain toward the east into the Colorado River while the northern section drains toward the north also into the Colorado River. The City is underlain by soils primarily of the Miller-Yahola-Trinity type, but some Bell-Axtell soils

TABLE HG-4

EXISTING WASTE LOADS

HOUSTON-GALVESTON AREA COUNCIL

City	Estimated Population Served	Discharge	Estimated Influent Loading			Estimated Treatment Reduction	Estimated Effluent Loading	
			Flow mgd	BOD lb./day	TSS lb./day		BOD lb./day	TSS lb./day
COLUMBUS	3,900	Yes	0.35	350	350	85% / 85%	52.5	52.5
EAGLE LAKE	3,500	Yes	0.29	326	726	80% / 80%	65.0	145.0
GARWOOD	480	Yes	0.04	50	127	80% / 80%	10.0	25.0
WEIMAR	2,000	Yes	0.17	298	142	52% / 50%	142.0	71.0
WHARTON	6,700	Yes	1.0	1,251	667	67% / 75%	417.0	167.0

are also present. The Miller-Yahola-Trinity soils generally have a 10- to 20-inch-thick, reddish brown, calcareous, clay surface over reddish brown, blocky, calcareous clay. The Bell-Axtell soils are generally gray, granular, calcareous clays with moderate permeability. The permeabilities of the predominant MillerYahola-Trinity soils range from 2.0 to 6.3 inches per hour. Septic tanks have moderate to severe limitations due to flooding, and sewage lagoons have severe limitations due to the high permeability.

Population data developed by the TWDB for use in this study indicate a slight increase in population is expected for Columbus over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	3,342	3,540	3,670	3,780

The land use for the City, generally typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along the two major thoroughfares and in the central area of the City. The economic resource base is primarily agricultural, with some contribution from local oilfield activities. The primary industrial contribution is derived from sand and gravel operations. Columbus has a general hospital and a nursing home which aid the local economy.

Accessible by both a State highway and an Interstate highway, the City is also served by the Southern Pacific Railroad. Anticipated growth potential, however, is slight due to a lack of adequate economic activity or resource availability. However, this trend could be markedly affected by the construction of the proposed Columbus Bend Reservoir a few miles northwest of Bastrop on the Colorado River. Construction of that reservoir could produce an extremely rapid population growth in the area. Only 70 miles from Houston, Texas, by Interstate highway, the area could prove to be one of the most rapidly developing lake developments in Texas. The lake development would stimulate the growth of the permanent population which would furnish construction and related services to the development.

The municipal water supply from a ground water source is drawn by three wells with pumping capacities of 800, 400, and 650 gpm. Storage for the system is provided by two 0.25 mg capacity ground tanks and a 0.30 mg capacity elevated tank. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

Year	1970	1980	1990	2020
Municipal Use	0.53	0.60	0.65	0.74

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

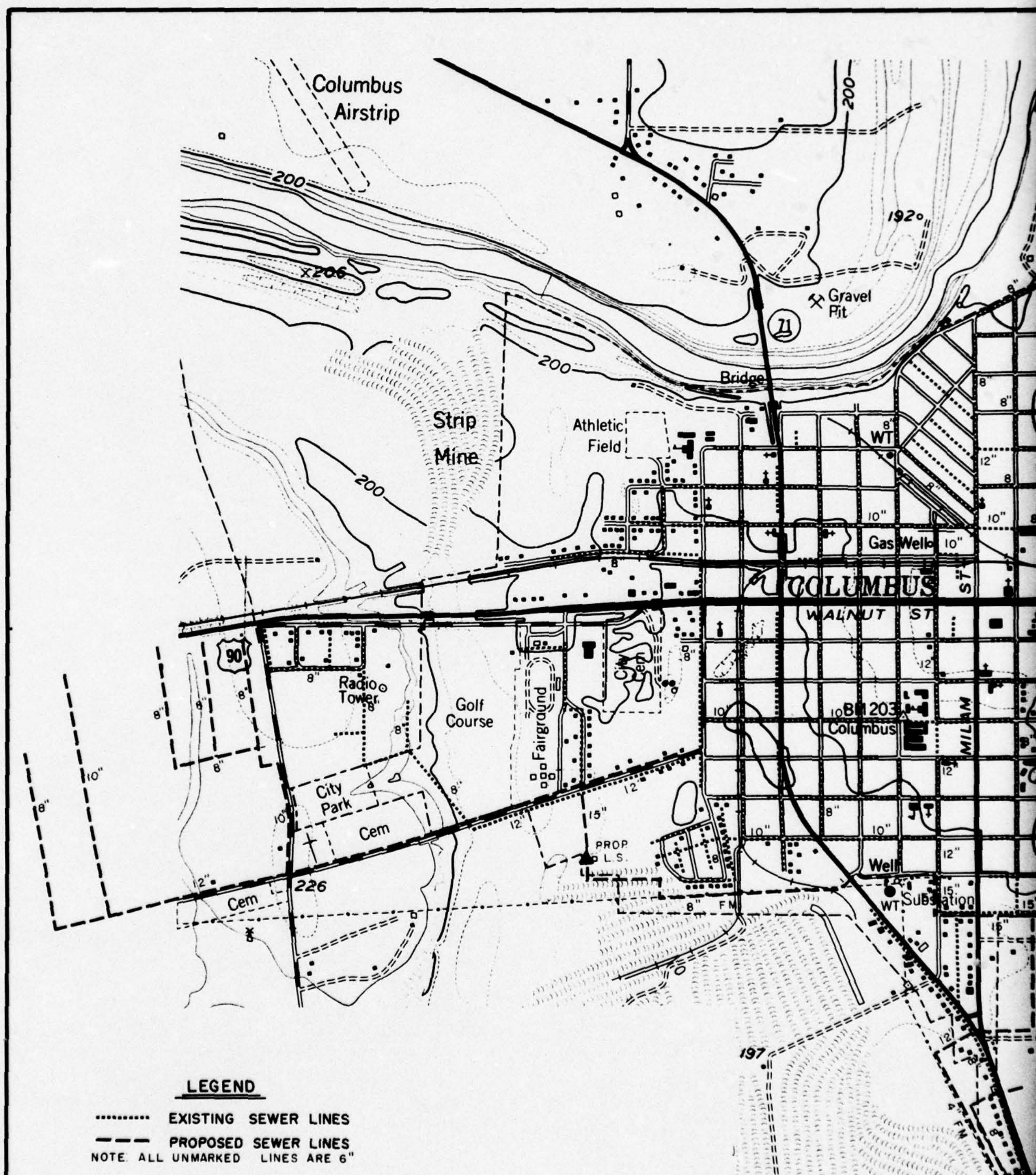
Waste Load Projections

	Year 1970	1980	1990	2020
Flow in mgd	0.33	0.35	0.37	0.38
BOD in lb/day	568	637	661	718
TSS in lb/day	668	743	807	869

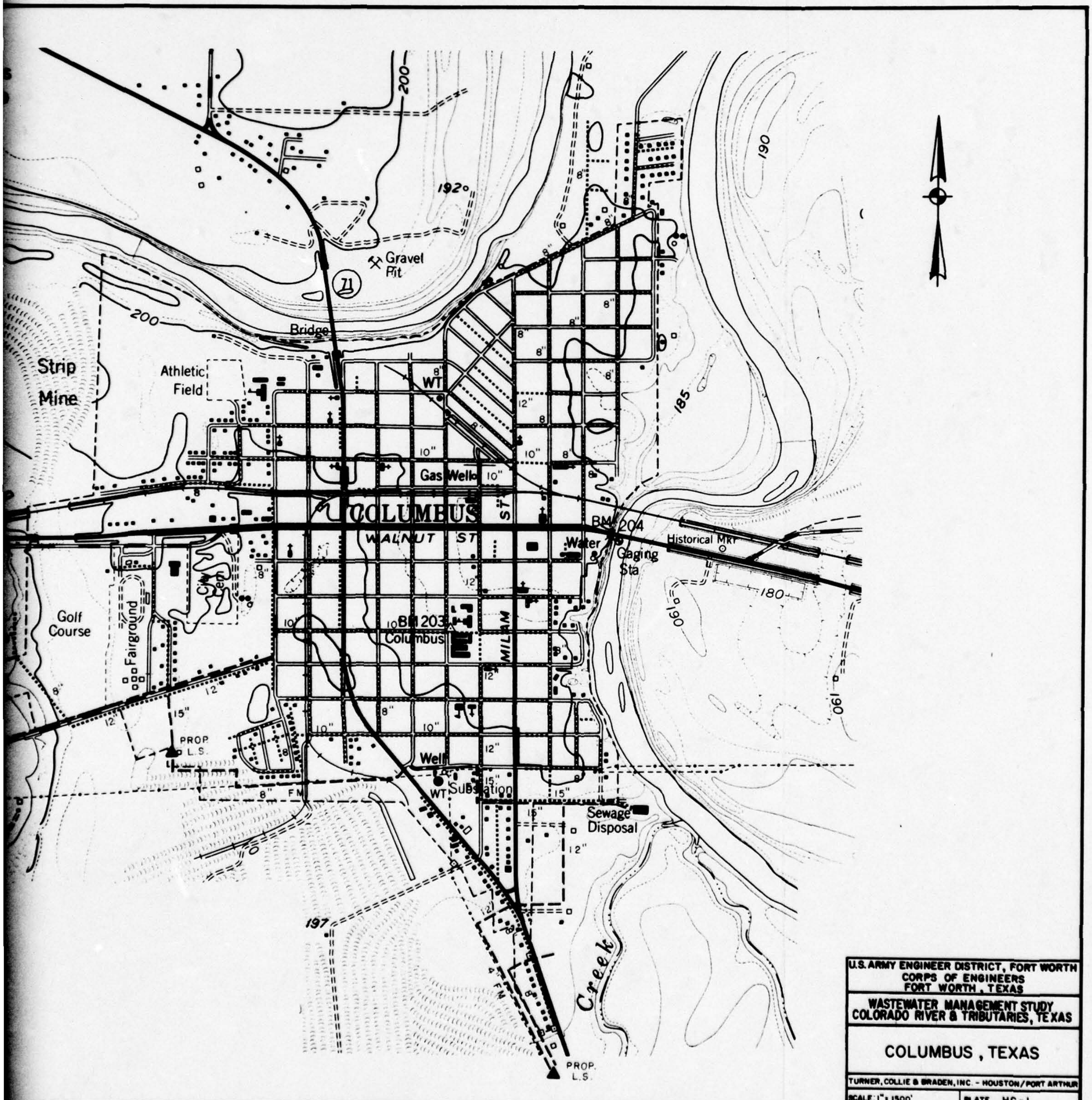
The existing wastewater collection system is shown on Plate HG-1. The system appears adequate to serve the existing serviced population. It is desirable, however, to expand the collection system to serve the southern portion of the City and provide relief on the western portion of the collection system with the addition of the relief sewer indicated on Plate HG-1. With only minor expansions and extensions as needed, these proposed lines should serve the needs of the slight population growth. The cost for the West Area proposed collection system improvements, including a pump station, 6,450 feet of 8-inch line, 3,700 feet of 10-inch line, 6,800 feet of 12-inch line, 2,950 feet of 8-inch force main, and engineering and contingencies, is estimated to be $376,700. The cost for the South Area proposed collection system improvements, including a pump station, 1,900 feet of 8-inch line, 2,200 feet of 12-inch line, 3,130 feet of 15-inch line, 2,000 feet of 4-inch force main, and engineering and contingencies, is estimated to be $169,300.

The existing sewage treatment plant for the City of Columbus is located on the banks of the Colorado River in the southeast corner of town, as shown on the Plate. The plant was built in 1972 with a design capacity of 0.65 mgd and presently serves about 3,900 people. It is in excellent physical condition and has been well maintained. The plant is of the contact-stabilization type and consists of a contact chamber, a clarifier, a settling tank, a reaeration tank, and chlorination facilities. At the time of this study, no sampling data published by the TWQB as part of their self-reporting data program were available to indicate the treatment efficiency of this new facility. Effluent from the plant is discharged into the Colorado River, and the dried sludge is hauled off to disposal sites.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of the law that a contact-stabilization type of plant will meet the requirements of the law until 1983 and be capable of producing an effluent with constituent levels at or below those established to define secondary treatment. Although mathematical modeling accomplished for this study has indicated no violation of existing stream standards would exist by discharge of a properly treated secondary waste from the City of Columbus throughout the planning period, by 1983 the City will be required to upgrade its



Columbus Airstrip
200
x206
Strip Mine
Gravel Pit
Bridge
Athletic Field
WT
Gas Well
COLUMBUS
WALNUT ST
MILAM
Radio Tower
Golf Course
Fairground
City Park
Cem
226
PROP. L.S.
BM 203 Columbus
Well
Substation
192
197
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES
NOTE. ALL UNMARKED LINES ARE 6"



Strip Mine
Athletic Field
Gravel Pit
Bridge
200
192
190
185
180
197
WT
Gas Well
COLUMBUS
WALNUT ST
MILAM ST
BM 204
Water & Gaging Sta
Historical Mkr
BM 203 Columbus
Golf Course
Fairground
City Cem
PROP. L.S.
Well
Substation
Sewage Disposal
Creek
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
COLUMBUS, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1500'
PLATE HG-1

2

level of treatment to be in compliance with the law. At that time the City may either install conventional tertiary waste treatment facilities or may utilize irrigation as the means of final effluent disposal.

Land disposal of effluent has proven to be an efficient and economically practicable method of providing a high degree of treatment of wastewaters throughout the Basin. The City may either contract with local farmers who would store and utilize the water for their crops, or the City may entirely own and operate the land disposal system.

The cost for a City-owned and operated land disposal system, including a 23.9-acre 60-day holding pond, irrigation equipment, 37.9 acres of land, and engineering and contingencies, is estimated to be $215,000. Economics can be gained by arrangements to utilize private land, by creating an impoundment in a dry draw or depression or by irrigating continuously throughout the year such that only a small holding pond would be required.

Utilization of effluent for irrigation purposes has proven to be an extremely viable method of disposal in the Basin area and will aid in enhancing the river quality by eliminating any unforeseen adverse impacts on the river from the discharge of a secondary wastestream.

It is therefor recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Columbus wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $162,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $143,000, including engineering and contingencies.

Eagle Lake, Texas.

The City of Eagle Lake is an incorporated, general law municipality located in the eastern portion of Colorado County at the intersection of U.S. 90A and F.M. 102 approximately 60 miles west of Houston, Texas. The incorporated area of the City encompasses approximately 820 acres and lies within the jurisdiction of the H-GAC.

The City has slight topographical relief with a general slope from northeast to southwest and a corresponding elevation decrease of approximately 20 feet. Runoff generally is toward an unnamed creek in the southwest section of the City which drains into the McCreary Lake.

The City is underlain by soils of the Katy-Edna type. Katy soils have a friable, acid surface, 12 to 20 inches thick, over a very firm, blocky, stiff, acid, sandy clay. The Edna soil has a friable, acid surface, 8 to 12 inches thick, over gray, compact, blocky, acid clay. Permeabilities range from 0.06 to 2.0 inches per hour, imposing severe limitations on septic tanks and slight to moderate limitations on sewage lagoons.

Population data developed by the TWDB for use in this study indicate that a slight increase in population is expected for Eagle Lake over the next 50 years. The population projections are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	3,587	3,800	3,960	4,110

Land use for the City, typical of that of other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is primarily based on rice farming with some contribution from local oilfield activity. Accessible by U.S. 90, the City is also served by the Atchison, Topeka, and Santa Fe Railroad and a municipal airport. Due to its proximity to Houston, the City is expected to feel some growth as weekend and vacation homes reach out from the metropolitan area.

The municipal water supply is obtained solely from ground water sources drawn by two wells with pumping capacities of 600 and 485 gpm. Storage is provided by two ground reservoirs with capacities of 0.10 mg and 0.30 mg and one elevated reservoir with a capacity of 0.30 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections *

	Year			
	1970	1980	1990	2020
Municipal Use	0.40	0.42	0.44	0.46
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.36	0.38	0.40	0.41
BOD in lb/day	610	684	713	781
TSS in lb/day	717	798	871	945

The existing wastewater collection system is shown on Plate HG-2. The system presently serves all areas in the densely inhabited area. The system consists primarily of 6- to 10-inch clay pipe with small amounts of four-inch pipe providing service to localized areas. There are no significant areas within the present city limits where septic tanks remain the primary means of sewage disposal, and with only minor expansions and extensions, the system should be generally adequate to serve the slight population increase. There are presently three outlying areas shown on Plate HG-2 that may be considered for service extensions. The costs, including engineering and contingencies to provide this service, are estimated to be as follows: Northwest Area - $89,600; White Cloud Church Area - $110,200; South Area - $41,100.

The existing sewage treatment plant for Eagle Lake is located in the southwest part of the City as shown on Plate HG-2. Constructed in 1951 with a design capacity of 0.50 mgd, the plant presently serves about 3,500 people, and apparently has been maintained in excellent physical condition. The plant is of the trickling-filter type and consists of a Parshall flume, lift station, primary clarifier, digestor, three sludge drying beds, trickling filter, final clarifier, and chlorination unit. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent-Effluent Data

	TSDH (1971)	TWQB (1969)
Raw BOD (ppm)	150	105
Raw TSS (ppm)	340	273
Final BOD (ppm)	6	95
Final TSS (ppm)	10	249

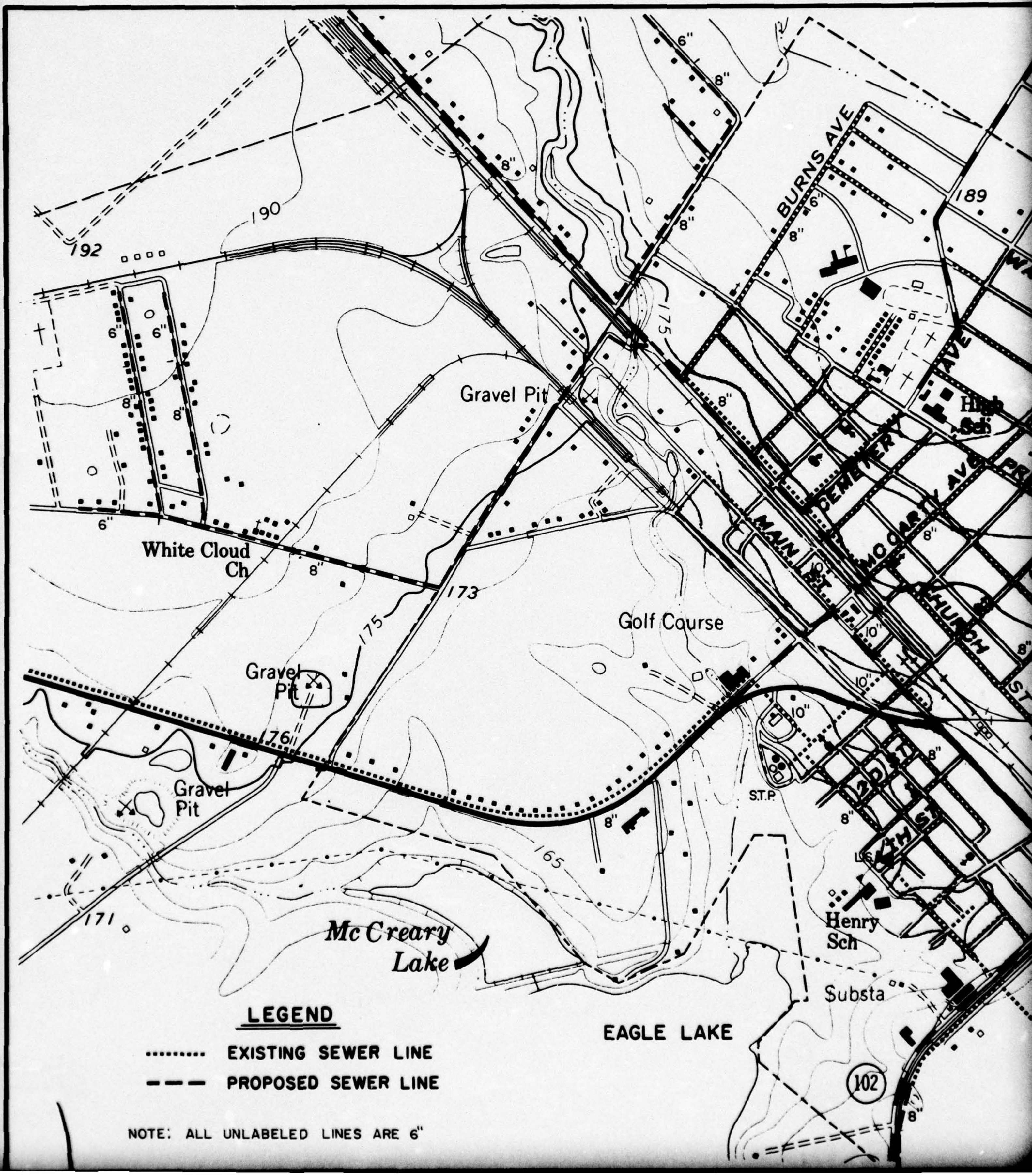
Sludge disposal consists of drying the material and then spreading it on the plant site. Effluent, after chlorination, is discharged into Eagle Lake. Eagle Lake is a limited-access private impoundment from which water is drawn for the irrigation of rice. There are no other present or forseeable waste contributing sources in the area.

Under the requirements of PL 92-500 publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the constituent levels which will be utilized to define secondary treatment will not be attainable solely by a trickling filter process, and the City will be required to provide a higher degree of treatment if it is to continue to discharge and if the present system of discharge into Eagle Lake and subsequent irrigation is not acceptable to State and Federal regulatory agencies. As an alternative to costly tertiary waste treatment facilities that a city the size of Eagle Lake would have difficulty supporting, it is proposed that the City dispose of all effluent through a system of controlled irrigation. Also, within the present interpretation of the law, land disposal of effluent meets all treatment requirements for 1977 and through 1985 when the disposal is executed in an approved manner and when no effluent is introduced into surface water or ground water resources either by direct runoff or by percolation without adequate treatment time.

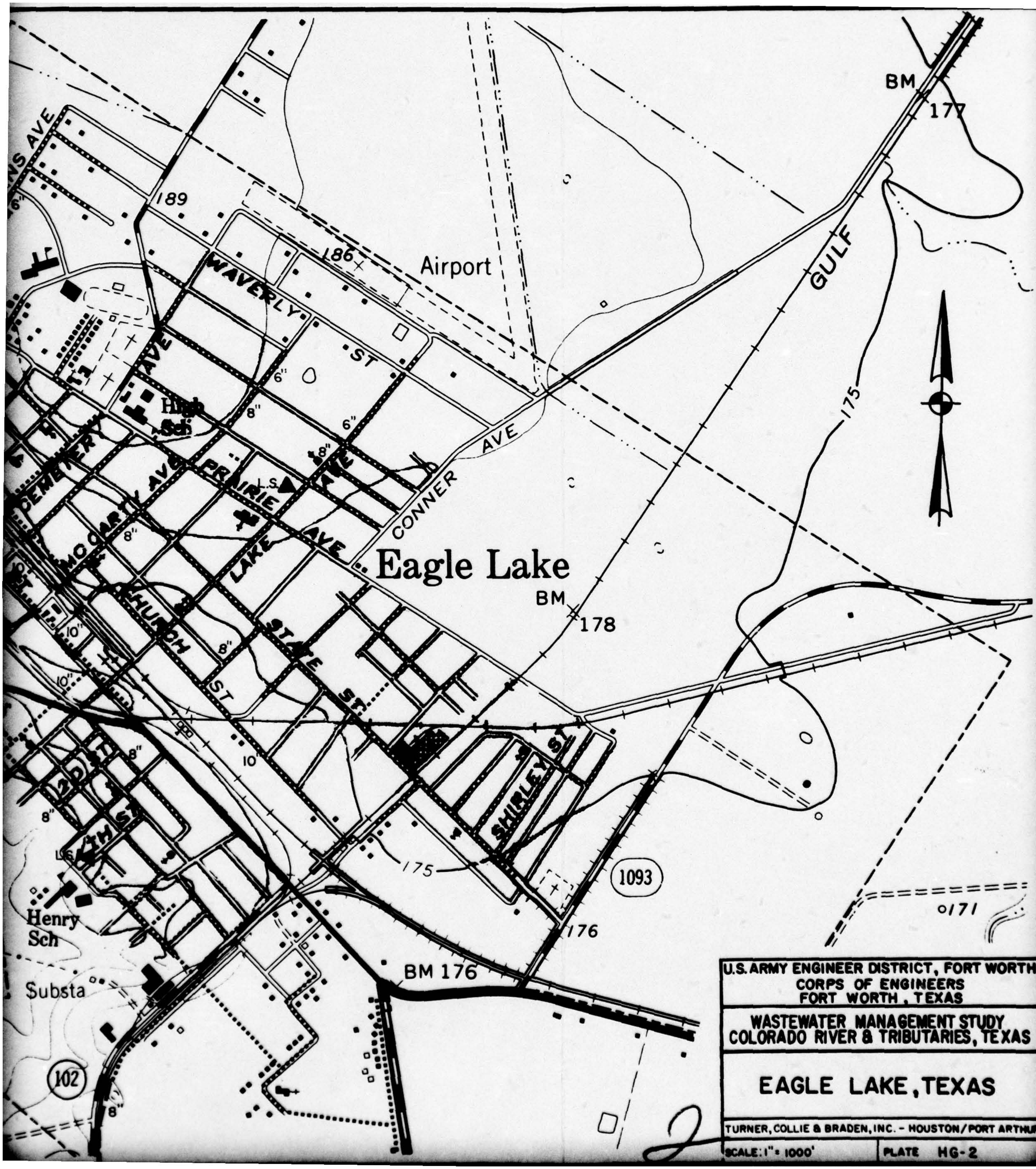
Should the City choose to dispose of all effluent by irrigation, two institutional alternatives are available. The City may either contract with a local farmer who would take all effluent and provide all irrigation facilities, or the City may own and operate the system. The estimated cost for a City-owned and operated system, including a 16.6-acre 60-day holding pond, irrigation equipment, 74.6 acres of land and engineering and contingencies, is $228,200. If arrangements can be made with local farmers to either take the water or allow the City to use their land, some substantial costs such as land acquisition can be greatly reduced. In addition, some economies can be effected by choice of impoundment location or length of irrigation season. A small dry draw could be made into a reservoir for substantially less than the estimated cost, and the need for a holding pond could be reduced significantly if the City should utilize irrigation on a year-round basis.

Utilization of effluent for irrigation purposes has been found to be a particularly viable means of wastewater disposal in many areas of the Colorado River Basin and has proven a valuable reuse of a scarce natural resource. The method also eliminates any adverse impacts on receiving watercourses that may be associated with the discharge of a secondary effluent.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Eagle Lake wish to implement a discharge plan, the following items would be required:



BURNS AVE
189
190
192
White Cloud
Ch
Gravel Pit
Golf Course
173
175
176
165
171
MAIN ST
CHURCH
S.T.P.
Henry
Sch
Substa
McCreary
Lake
EAGLE LAKE
102
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNLABELED LINES ARE 6"



Airport
WAVERLY ST
CONNER AVE
PRAIRIE AVE
LAKE AVE
CEMETERY AVE
McCARTY AVE
CHURCH ST
STATE ST
SHIRLEY ST
GULF
Eagle Lake
High Sch
Henry Sch
Substa
BM 177
BM 178
BM 176
189
186
175
176
171
1093
102
L.S.
6"
8"
10"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
EAGLE LAKE, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 1000'
PLATE HG-2

1. By 1977, construct a conventional secondary treatment facility of at an approximate capital cost of $358,500, including engineering and contingencies

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $156,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $143,000, including engineering and contingencies.

Garwood, Texas.

The City of Garwood is an unincorporated municipality located in the southeast portion of Colorado County at the intersection of S.H. 71 and S.H. 950 approximately 65 miles southwest of Houston, Texas. The inhabited area of the City encompasses approximately 750 acres and is located within the jurisdiction of the H-GAC. The general direction of drainage for the City is toward the southeast into an unnamed tributary which flows into the Colorado River below the populated area.

The City is underlain by soils of the Katy-Edna and Miller-Norwood types. The Katy-Edna fine sandy loams generally have a gray, friable, acid surface, 12 to 20 inches thick, over stiff, acid clay, while the Miller-Norwood soils are dark reddish brown, generally crumbly, calcareous clays. Surface permeabilities for the Garwood area ranges from 0.63 to 2.0 inches per hour. Septic tanks have only slight limitations due to flooding, and sewage lagoons have moderate limitations due to the high permeability.

Population data developed by the TWDB for use in this study indicate that a slight decrease in population is expected for Garwood over the next 50 years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	961	910	890	750

It should be noted, however, that the exact population of an unincorporated area is difficult to define and in many instances the stated population is the school, church, or business population--which can include vast areas away from the densely inhabited area. It appears from a house count and field visitations accomplished for this study that the actual population within the immediate vicinity is approximately 500. This study agrees with the general trend indicated by the above projections but has adjusted all data to approximate local conditions. Land use for the City, typical of that found in other small cities, is characterized by scattered residential development

and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oilfield activity. Some contribution is derived from local gravel and sand operations.

Accessible by two State highways, the City is served by the Sante Fe Railroad and a local airport. Anticipated growth potential is slight due to a lack of adequate economic activity and resource availability.

The municipal water supply is obtained from ground water sources by two wells which serve the City, with pumping capacities of 300 and 30 gpm. Storage for the system is provided by a 0.05-mg capacity elevated storage tank. Based on TWDB population projections, the water use has been projected to be as follows:

Water Use Projections*

Year	1970	1980	1990	2020
Municipal Use	0.11	0.10	0.10	0.09

*Flows in mgd

Also based on TWDB population projections, municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

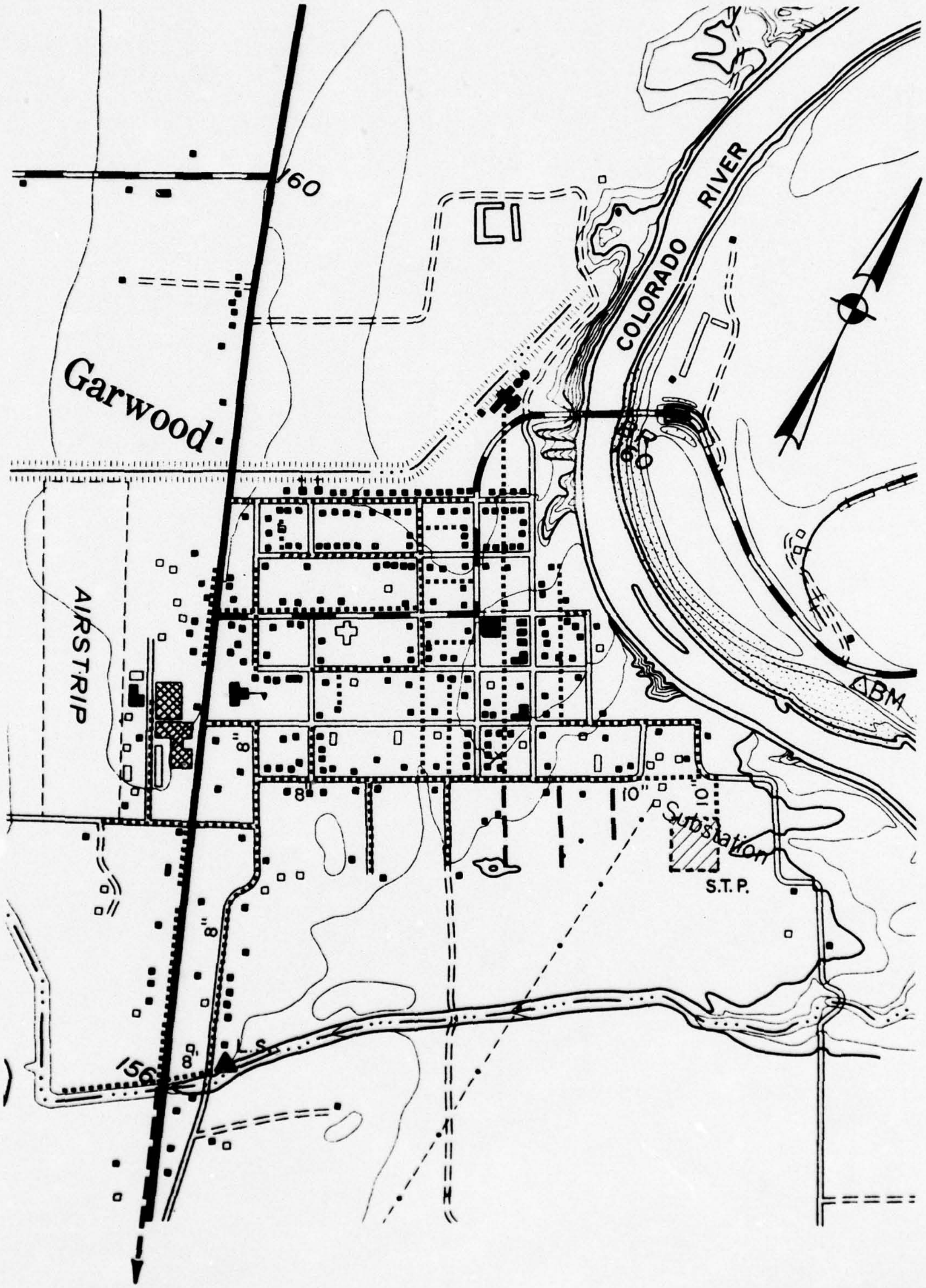
Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.10	0.08	0.08	0.06
BOD in lb/day	163	153	144	114
TSS in lb/day	192	178	176	138

These projections must be reduced proportionately according to the population redefinition previously stated.

The existing wastewater collection system is shown on Plate HG-3. The system is generally adequate for present needs, and if the minor extensions shown are incorporated, the system should meet the future needs of the declining population. The costs, including engineering and contingencies, for these expansions are estimated to be $34,200.

At the present time no industrial wastewater is contributed to the municipal system, and there are no significant areas of the town where septic tanks are utilized.



LEGEND

·······	EXISTING SEWER LINES
— —	PROPOSED SEWER LINES

NOTE: ALL UNMARKED LINES ARE 6"

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

GARWOOD, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

The existing sewage treatment plant for the City of Garwood is located southeast of town, as shown on the Plate. The plant was built in 1960 with a design capacity of 0.054 mgd and presently serves about 480 people. The plant is of the trickling-filter type and consists of a primary clarifier, a trickling filter, an anaerobic digestor, an oxidation pond, and sludge drying beds. According to local sources, the present plant loading is below the stated capacity of the facility. Available sampling data, published by the Texas State Department of Health, are as follows:

Influent - Effluent Data

	TSDH (1972)
Raw BOD (ppm)	150
Raw TSS (ppm)	380
Final BOD (ppm)	30
Final TSS (ppm)	74

Sludge disposal consists of spreading the dried material around the plant site, and effluent is discharged into a ditch which flows into the Colorado River.

Based on the population currently served and those areas destined for proposed service, the present treatment facility would be adequate throughout the planning period. However, under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the present interpretation of the law that the level of discharge constituents which will be utilized to define secondary treatment will not be attainable by a trickling-filter process such as employed by Garwood. As an alternative to costly conventional secondary facilities or tertiary facilities that the City could neither afford to purchase nor operate, it is proposed that effluent from the treatment plant be disposed of entirely through irrigation by 1977 to be in compliance with the law. Also, within the present interpretation of the law, irrigation or land disposal of effluent meets all treatment requirements for 1977 and through 1985 when the disposal is executed in an approved manner and when no effluent is introduced into surface water or ground water resources either by direct runoff or percolation without adequate treatment time.

Should the City choose to dispose of all effluent by irrigation, two institutional alternatives are available. Since, according to data furnished by the General Land Office, the City is located in an area where irrigation is practiced, it may either contract with a local farmer who would take all effluent and provide all irrigation facilities, or the City may own and operate the system. The cost for a City-owned and operated system, including a 2.0-acre 60-day holding pond, irrigation equipment, 5.7 acres of land, and engineering and contingencies, is estimated to be $44,000.

If arrangements can be made with local farmers to either take the water or allow the City to use their land, some costs such as land acquisition can be greatly reduced. In addition, some economies can be effected by choice of the impoundment location; a small dry draw could be made into a reservoir for substantially less than the estimated cost.

Utilization of effluent for irrigation purposes has been found to be a particularly viable means of wastewater disposal in many areas of the Colorado River Basin and has provided a valuable means of reutilizing the natural resource. The method also eliminates any adverse impacts on receiving watercourses that may be associated with the discharge of a secondary effluent.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Garwood wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $76,000, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $78,800, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $78,500, including engineering and contingencies.

Weimer, Texas.

The City of Weimer is an incorporated, general law municipality situated in the western portion of Colorado County at the intersection of U.S. 90 and F.M. 155, approximately 110 miles west of Houston, Texas. The incorporated area of the City encompasses approximately 760 acres and is located within the jursidiction of the H-GAC.

Weimar is situated on a slightly elevated portion of land so drainage proceeds outward from all four sides of town. Runoff predominently flows into Clear Creek to the south of town and Harvey's Creek to the north of town.

The City is entirely underlain by the Houston and Crockett soil types. The Houston soils have a crumbly, calcareous, clay surface, generally 6 to 15 inches thick, over a blocky, highly calcareous clay. Crockett soils characteristically have a friable, acid, sandy loam to clay loam surface, approximately 7 to 12 inches thick, over a very firm and very plastic, blocky, acid

clay. The surface soil is very tight and crusty when dry, and calcium carbonate concretions exist below 50 inches. Surface permeabilities for these soils are less than 0.06-inch per hour. Due to the slow permeability of the soil, there are severe limitations on septic tanks but only slight limitations on sewage lagoons, depending on the side slopes.

Population data developed by the TWDB for use in this study indicate that a slight decrease in population is anticipated for Weimar over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,104	1,990	1,940	1,640

Land use for the City, typical of that found in other small cities, is characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource is primarily based on production of rice and other crops with some industrial contribution from local gravel operations and a stone plant. The City also has a hospital and clinic which contribute to the economy.

Accessible by a U.S. highway, the City is also served by the Southern Pacific Railroad. Anticipated growth potential is slight; however, due to a lack of adequate ecomonic activity and available resources.

The municipal water supply, obtained from ground water sources, is drawn by five wells with pumping capacities of 200, 250, 350, 400, and 400 gpm. Storage is provided by two ground reservoirs with capacities of 0.80 mg and 0.060 mg and a 0.75 mg capacity elevated reservoir. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections*

	Year			
	1970	1980	1990	2020
Municipal Use	0.24	0.23	0.22	0.19
Industrial Use	None	None	None	None

*Flows in mgd

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.21	0.19	0.18	0.13
BOD in lb/day	358	342	324	255
TSS in lb/day	421	399	396	308

The existing wastewater collection system for the City is illustrated on Plate HG-4. The system is apparently adequate for present needs, and with the minor extensions of service shown should be adequate to serve the needs of the projected declining population. The costs for these extensions, including engineering and contingencies, are estimated to be $43,000.

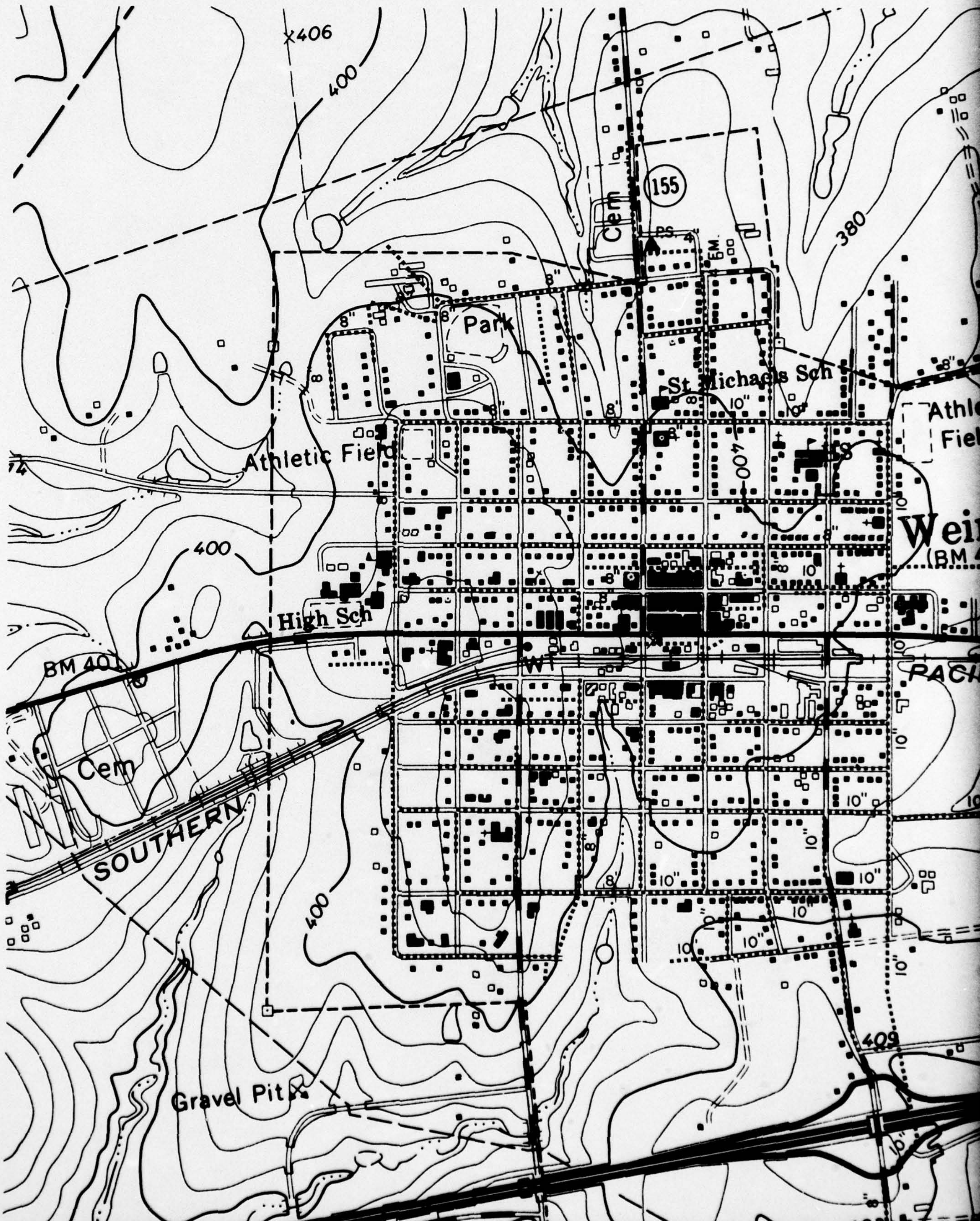
The existing sewage treatment facility for Weimar is located east of the City as shown on Plage HG-4. Constructed in 1950, with a design capacity of 0.5 mgd, the plant presently serves about 2,000 people with 760 connections. The plant is of the oxidation pond type and consists of three oxidation ponds in series with two mechanical aerators in the first pond. Available sampling data published by the Texas State Department of Health and TWQB are as follows:

Influent - Effluent Data

	TSDH (1971)	TWQB (1969)
Raw BOD (ppm)	120	210
Raw TSS (ppm)	50	101
Final BOD (ppm)	25	100
Final TSS (ppm)	112	47

No separate disposal of sludge is presently undertaken. Effluent from the oxidation pond is discharged into Harvey's Creek which is tributary to the Colorado River. There is presently no significant industrial waste contribution to the plant's influent.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the constituent levels which will be utilized to define secondary treatment cannot be attained by the present mode of treatment. Therefore, as an alternative to costly conventional secondary or tertiary waste treatment facilities that a city the size of Weimar would have difficulty supporting, it is proposed that effluent from the treatment plant should be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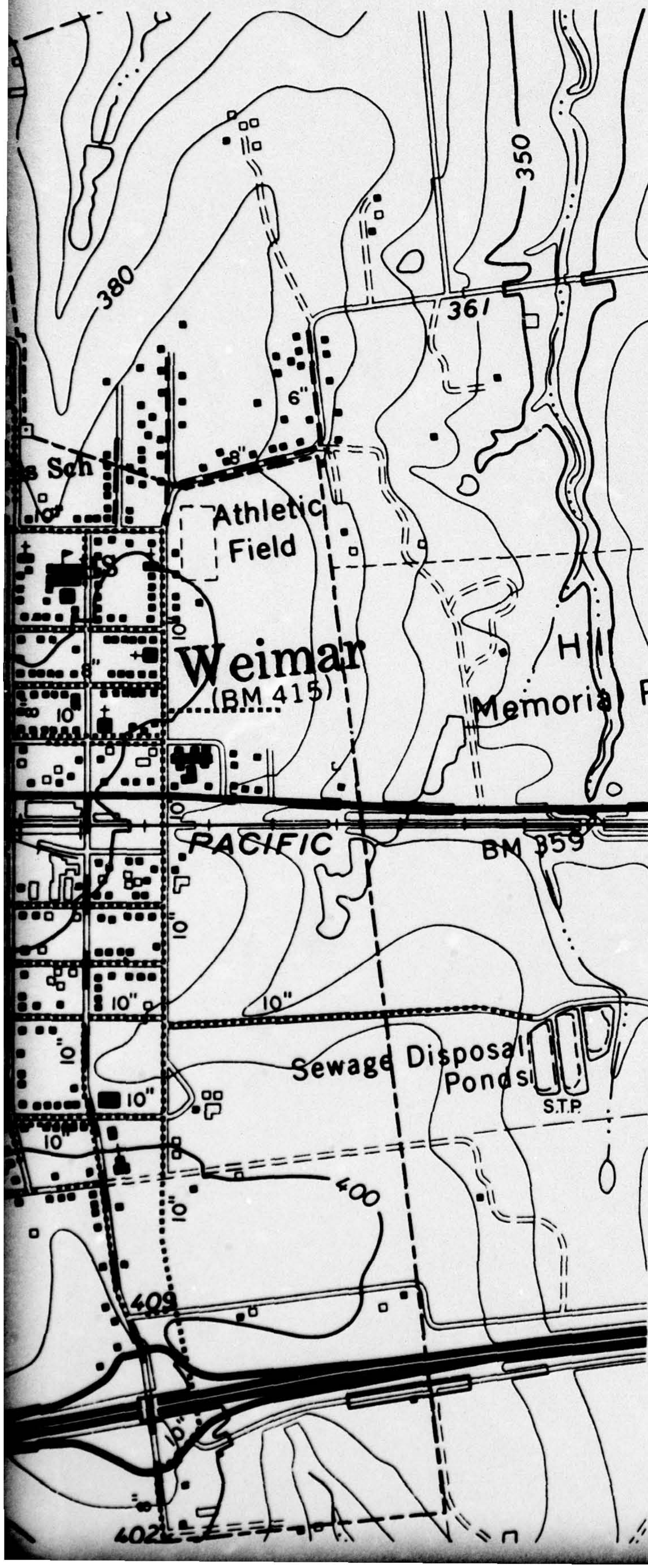

LEGEND

.... EXISTING SEWER LINES

— — — PROPOSED SEWER LINES

NOTE: ALL UNLABELED LINES ARE 6"

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disposed of entirely through irrigation by 1977 to be in compliance with the law. Also within the present interpretation of the law, irrigation or land disposal of effluent as proposed, meets all treatment requirements for 1977 and through 1985 when the disposal is executed in an approved manner and when no effluent is introduced into surface water or ground water resources either by direct runoff or percolation without adequate treatment time.

Should the City choose to dispose of all effluent by irrigation, two institutional alternatives are available. The City may either contract with a local farmer who would take all effluent and provide all irrigation facilities, or the City may own and operate the system. The cost for a City-owned and operated system, including a 7.4-acre 60-day holding poind, irrigation equipment, 33.2 acres of land, and engineering and contingencies, is estimated to be $116,300. If arrangements can be made with local farmers to either take the water or allow the City to use their land, some costs such as land acquisition can be greatly reduced. In addition, some economies can be affected by choice of the impoundment location or a year round irrigation operation which would reduce the need for additional holding facilities.

Utilization of effluent for irrigation purposes has been found to be a particularly viable means of wastewater disposal in many areas of the Colorado River Basin and has proven to be a valuable method of reuse of a scarce natural resource. The method also eliminates any adverse impacts on receiving watercourses that may be associated with the discharge of a secondary effluent.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Weimar wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $122,000, including engineering and contingencies.
2. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $84,000, including engineering and contingencies.

Wharton, Texas.

The City of Wharton is an incorporated home rule municipality situated in the central portion of Wharton County at the intersection of U.S. 59 and S.H. 60, approximately 40 miles southwest of Houston, Texas. The incorporated area of the City encompasses approximately 1,600 acres. Wharton is the county seat of Wharton County and is located within the jursidiction of the H-GAC.

The topographic relief of Wharton is slight, even though the City is located on the drainage divide between the Colorado and Brazos River Basins. The southern portion of the City drains into the Colorado River to the south while the northern portion drains predominantly north into Boughman Slough.

The City is underlain by Miller-Norwood soils and Miller Pledger clays. Miller soils have a crumbly, calcreous clay surface, 10 to 20 inches thick over crumbly, subangular, blocky, calcareous clay. Norwood soils have friable, strongly calcareous, silt loam silty, clay loam surface, 9 to 25 inches thick, over very friable, granular, silt loam or silty clay loam several feet thick. Pledger clays have a friable, neutral to alkaline clay surface, about 10 to 20 inches thick, over a very firm, massive, strongly calcareous clay surface. Permeabilities for the Miller and Norwood soils range from 0.63 to 2.0 inches per hour. There are slight limitations on septic tanks due to the slow permeability. For the Miller and Pledger clays, surface permeabilities range from 0.06 to 0.2 inches per hour. Septic tanks have severe limitations due to the slow permeabilities while sewage lagoons have only slight limitations.

Population data developed by the TWDB for use in this study indicate that a slight increase in population is expected for Wharton over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	7,880	8,900	9,170	9,310

Land use for the City, generally typical of that found in other small cities, is characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is based primarily on rice production in the surrounding areas with some contribution from local oilfield activity. Light industrial contribution to the economy is derived from mineral processing plants, the Guffery Packing Plant, and the Wharton Beverage Company.

Accessible by a U.S. highway and a State highway, the City is also served by the Sante Fe and Southern Railroads and an FAA approved municipal airport. The City is expected to grow slightly due to industrial interest in the area.

The municipal water supply is obtained solely from ground water sources by three wells with capacities of 1,000 gpm each storage is provided by two ground reservoirs with capacities of 0.50 mg each and one elevated reservoir with a capacity of 0.30 mg. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections

	Year 1970	1980	1990	2020
Municipal Use	0.90	1.0	1.0	1.1
Industrial Use	0	0	0.01	0.01

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flow in mgd	0.79	0.89	0.92	0.93
BOD in lb/day	1,334	1,602	1,651	1,769
TSS in lb/day	1,576	1,869	2,017	2,141

The existing wastewater collection system, shown on Plate HG-5, serves the City and an estimated 100 persons outside the city proper. The proposed system, also shown on Plate HG-5, will provide service to four areas of the City presently utilizing septic tanks and will serve the anticipated future population expansion projected for Wharton. The total project cost for providing service to the four previously mentioned areas is $607,700, including engineering and contingencies. This total cost includes $227,700 for the Southeast Area, $166,200 for the Northeast Area $50,000 for the North Area and $163,800 for the West Area.

The existing sewage treatment plant for Wharton is located south of the City, as shown on the Plate. Constructed in 1963, with a design capacity of 0.70 mgd, the plant presently serves about 6,700 people, the Guffery Packing Plant, and the Wharton Beverage Company. The facility has apparently been maintained in good operational and mechanical condition. It is of the trickling-filter type and consists of a grit chamber, bar screen, primary clarifier, high-rate trickling filter, final clarifier, anaerobic digestor, chlorination unit, and sludge drying beds.

Influent-Effluent Data

	TSDH (1972)	TWQB (1972)
Raw BOD (ppm)	80	80
Raw TSS (ppm)	80	84
Final BOD (ppm)	50	50
Final TSS (ppm)	20	20

Sludge disposal consists of spreading the dried material around the plant site and hauling the remainder to the country club for use as fertilizer. Effluent from the chlorination unit is discharged into the Colorado River. Due to infiltration characteristic of the area, some bypassing occurs in the collection system, and approximately 0.40 mgd of untreated waste per month are released following chlorination.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977, and the best practicable waste treatment technology by 1983. It is the current interpretation of the law that the constituent levels which will be utilized to define secondary treatment, will not be attainable by a trickling filter process such as utilized by the City. As the present facility is at or near its design capacity, the City is currently considering plans for a new activated-sludge type plant of 1.5 mgd capacity. A secondary facility of this type would have adequate capacity throughout the planning period and would meet all treatment requirements to year 1983. Although population and wasteload projections accomplished for this study do not justify a plant capacity of 1.5 mgd, unknown industrial contribution or locally foreseen system or contributing area expansions may justify the need. For purposes of the remainder of this report, it will be assumed from the waste load projections that 1.0 mgd of capacity will be adequate.

It should be pointed out initially that the City has a sizeable investment in the existing facility for which a substantial outstanding debt must remain. In light of the requirements of PL 92-500, the City has as a minimum the following alternatives:

1. Add an increment of expansion to the present plant in the form of a parallel activated-sludge unit, blending the final effluent. Since, for the purpose of this study, an acceptable level of secondary treatment was defined to have associated BOD_5 and TSS concentrations of 20 ppm, the comingling of these effluents is not anticipated to produce an acceptable secondary effluent. As such, the City would be required to upgrade the level of treatment by 1977 to at least a 20/20 effluent. As an alternative to costly partial tertiary facilities to meet this goal, it would be proposed to dispose of all effluent by irrigation. Irrigation disposal would meet all requirements of the law for 1977 and through 1983.

New Zion
Bethel Ch
Baughman
Slough
Caney
Creek
SOUTHERN
PACIFIC
PROPOSED
P.S.
Wharton
Junior College
County
Fairgrounds
WHARTON
Cem
Oil Tank
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BM 101
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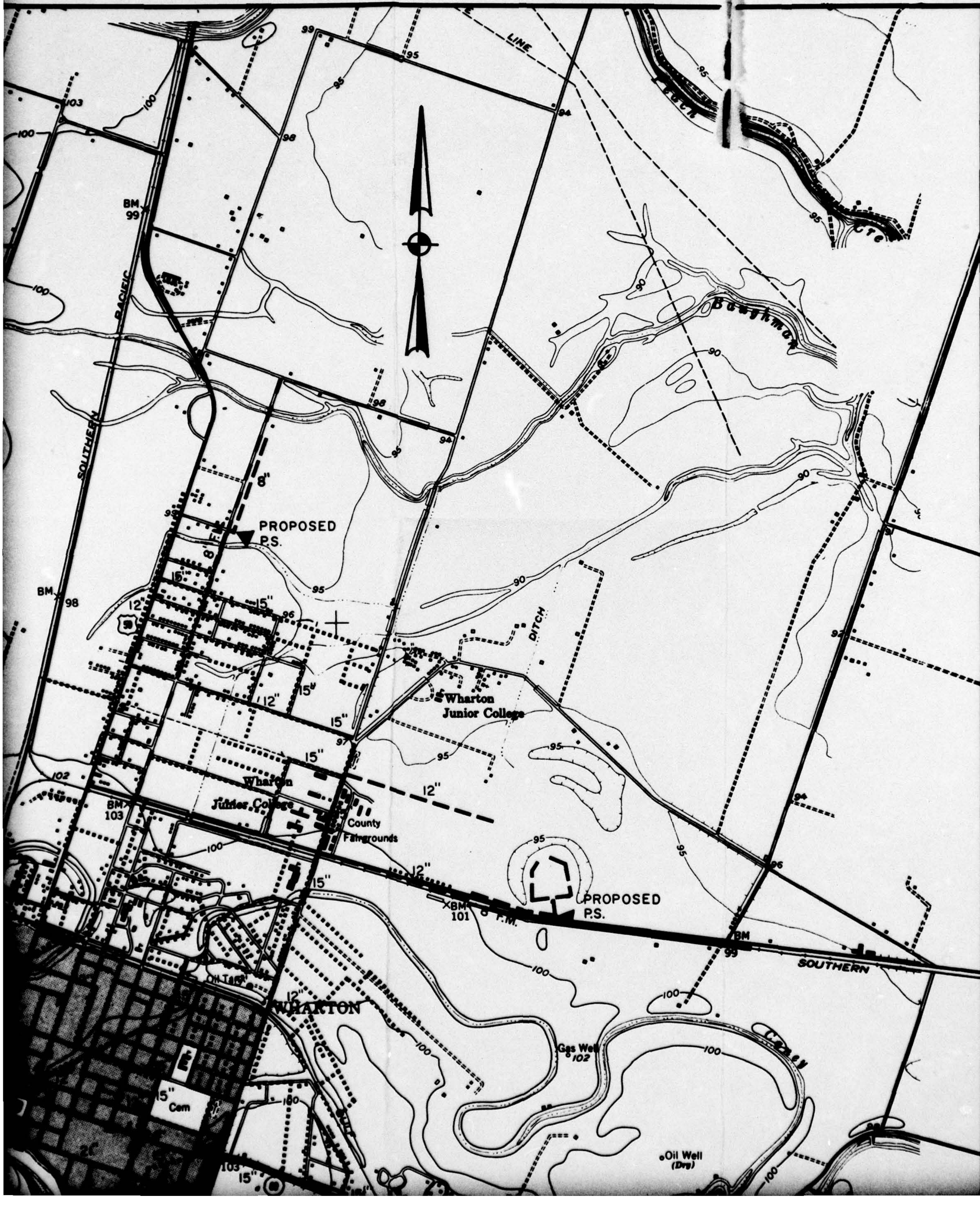

PROPOSED
P.S.
PROPOSED
P.S.
Wharton
Junior College
Wharton
Junior College
County
Fairgrounds
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PACIFIC
SOUTHERN
LINE
DITCH
Baughman
Caney
Gas Well
102
Oil Well
(Dry)
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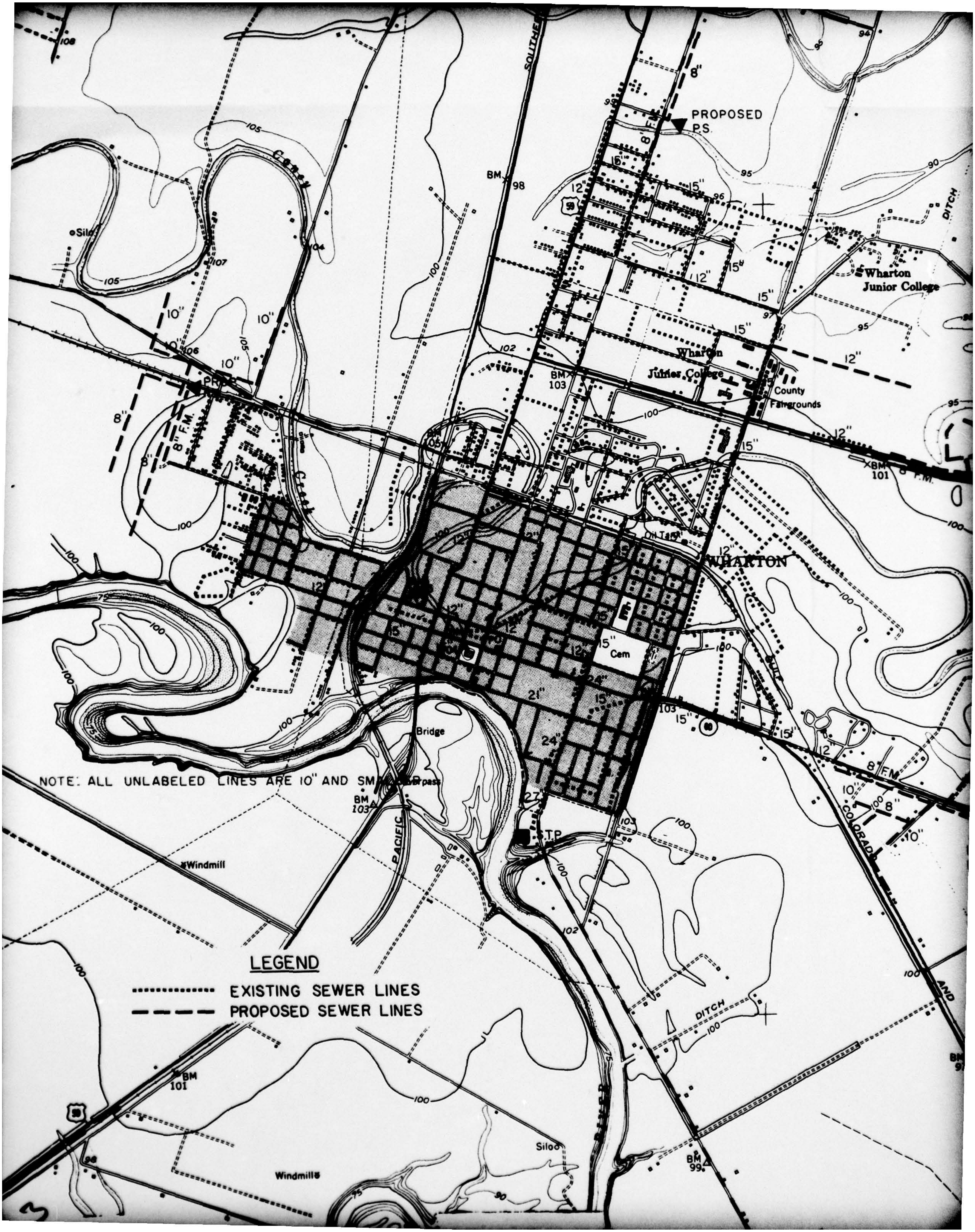
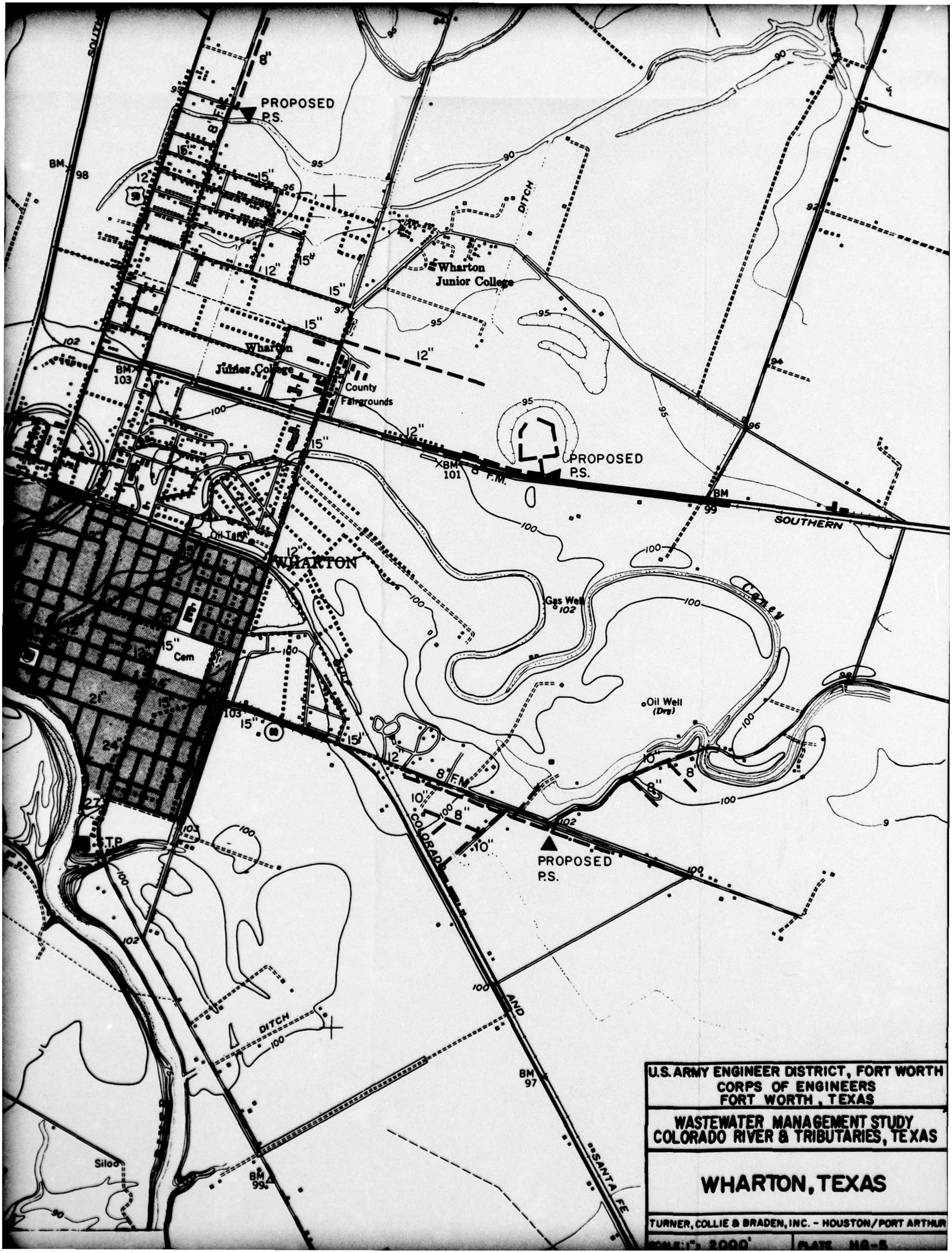


PROPOSED P.S.
Wharton Junior College
Wharton Junior College
County Fairgrounds
WHARTON
Cem
Bridge
Overpass
T.P.
Windmill
Silo
Windmill
NOTE: ALL UNLABELED LINES ARE 10" AND SMALLER
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES



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WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

WHARTON, TEXAS

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SCALE: 1" = 2000' | PLATE MG-5

2. As under consideration, the City could construct an activated-sludge facility to replace the present trickling-filter plant. An activated-sludge unit would be capable of producing an acceptable secondary effluent and would thus place the City in full compliance with the law until 1983. At that time the City would again be required to upgrade its level of treatment. As in Alternative No. 1, irrigation with all effluent would be the proposed disposal method, to avoid costly coventional tertiary facilities.

The alternative comparison, therefore, is between an increment of expansion and a new facility, each with subsequent irrigation--one in 1977 and one in 1983. The cost of a 0.3-mgd activated-sludge increment of expansion is estimated to be $252,000, including engineering and contingencies. The cost of a new 1.0-mgd activated-sludge facility is estimated to be $627,500, including engineering and contingencies, but exclusive of any salvable items of the existing plant. It is recommended that the 0.3-mgd increment of expansion be implemented.

Should the City choose to dispose of all effluent by irrigation, two institutional alternatives are available. The City may either contract with a local farmer who would take all the effluent and provide all irrigation facilities, or the City may own and operate the system. The cost of a City-owned and operated system, including a 34.3-acre 60-day holding pond, irrigation equipment, 154 acres of land, and engineering and contingencies, is estimated to be $551,200. If arrangements can be made with local farmers to either take the water or allow the City to use their land, some costs such as land acquisition can be greatly reduced. Field investigations accomplished for this study revealed that a sizable tract of pastureland exists across the Colorado River from the plant site that may offer some possibility for use as an irrigation site. If so, the above cost estimates should be adjusted accordingly.

Utilization of effluent from irrigation purposes has been found to be a particularly viable means of wastewater disposal in many areas of the Colorado River Basin and has proven a valuable reuse of a scarce natural resource. The method also eliminates any adverse impacts on receiving watercourses that may be associated with the discharge of a secondary effluent.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Wharton wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $627,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $343,000, including engineering and contingencies.

3. **By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $244,000, including engineering and contingencies.**